TM

HUSKY FS/2

System Developer's Guide

Husky FS/2
System Developer's Guide

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Electromagnetic Compatibility (EMC)

The **FS/2** must only be used with approved peripherals and approved AC adaptors; shielded communications cables must be employed.

Changes or modifications could void the user's authority to operate the equipment.

European EMC Regulations

This equipment complies with EN55022 Class B.

FCC Statement

RADIO INTERFERENCE

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

CAUTION

Unapproved modifications, or operations beyond or in conflict with these instructions for use, may void authorisation by the FCC to operate the equipment.

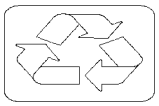
CAUTION

Approved accessories only may be used with this equipment. In general all cables must be shielded, correctly terminated and normally restricted to 2 metres length. Husky AC adaptors employ special provisions to avoid radio interference and should not be altered.

ATTENTION

- The FS/2 contains a recyclable nickel cadmium internal battery.
- If the FS/2 is used with rechargeable nickel cadmium batteries, these should be recycled at the end of their life.

DISPOSAL OF Ni-Cd BATTERIES



- Products containing nickel and cadmium require special attention.
- Such materials are hazardous to the environment, please recycle.
- It may be illegal to dispose of such materials via your public waste system.
- Check with your local solid waste authority for proper instructions.
- If you are responsible for product disposal, the internal battery may be extracted by removing the ring of case screws, opening the case halves, locating the battery and cutting its supporting leads.

AC ADAPTOR PRECAUTIONS

USE THE AC POWER ADAPTOR ONLY AFTER READING AND UNDERSTANDING THE FOLLOWING PRECAUTIONS.

Husky AC Adaptors are class II (double insulated with no earth) and built to EN60950: 1988 or EN60742: 1989, BS415 and DIR73/23/EEC safety requirements, and international EMC standards including EN55022 classes A & B.

Husky AC Adaptors supplied for use in North America meet UL safety requirements, and FCC Part 15 EMC regulations, classes A and B.

- Hazardous voltages inside, do not attempt to open.
- No user serviceable parts inside, do not attempt to open.
- Indoor use only.
- Avoid liquid spillage, do not connect if suspected damp.
- Ensure ventilation is not restricted.
- Use only the **Husky FS/2 AC Adaptor**. This special adaptor should never be replaced by an alternative unapproved model, as damage may result.
- Inspect adaptor before connecting, do not use if there are signs of damage or deterioration.
- Ensure rechargeable batteries are fitted and they are orientated correctly.
- Battery chemical leakage is corrosive, do not touch. (In case of accidental contact wash immediately with running water.)
- Ensure that connectors are firmly mated.
- Avoid mechanical strain to cables or connectors.
- Switch on or connect mains (line) supply only after making all connections.
- Switch off or disconnect mains (line) supply before disconnecting.

- In the event of overloading due to a fault, the adaptor is designed to be fail safe and may stop functioning.
- Do not attempt to employ the FS/2 AC Adaptor for alternative purposes; only use with the **FS/2**, **Hunter 16**, and **Hunter 16/80** products supplied by Husky Computers.
- Use only a readily accessible power outlet, and disconnect when not in use.
- Although the AC Adaptor is rated for continuous operation, it is important not to exceed the charging limitations of the battery. Refer to appropriate instructions on charging regime.
- Avoid use in dusty or contaminated environments.

Contents

Part 1: Introduction

Chapter 1 Welcome to the Husky FS/2 1
1.1 The FS/2 system 2
1.2 Features 2
1.3 Options 3

Chapter 2 The FS/2 Guides 5

Chapter 3 Using this Guide 7
3.1 Structure 7
3.2 Suggested reading approach 8
3.3 Conventions 8

Part 2: Setting Up

Chapter 4 Introduction 11

Chapter 5 Setting Up 13
5.1 About the FS/2 13
5.2 Fitting batteries 15
5.3 Turning on 16
5.3.1 Turning on for the first time 16
5.3.2 Turning on at other times 17
5.4 Configuring the FS/2 17
5.4.1 Power management 17
5.4.2 Time and date 18
5.4.3 Ports 18
5.4.4 System files 18
5.4.5 International keyboards 19
5.4.6 Rebooting 20
5.5 Installing the application 20
5.5.1 Copying the files 20

5.5.2 Setting up the application 20
5.5.3 Running the application 21

Chapter 6 Issuing the Unit 23

Chapter 7 Using the FS/2 25
7.1 Turning on and off 25
7.2 Rebooting 25
7.3 The screen 26
7.3.1 Introduction 26
7.3.2 Visibility 27
7.3.3 Moving around the virtual screen 28
7.3.4 Screen map key 29
7.3.5 Split screen 29
7.3.6 Inverse video 30
7.4 The keyboard 32
7.4.1 Introduction 32
7.4.2 Normal keys (default keyboard mode) 33
7.4.3 Shifted keys (default keyboard mode) 34
7.4.4 Special keys 35
7.5 Using MS-DOS 36
7.6 EMC legislation 39

Chapter 8 Regular Maintenance 41
8.1 Routine maintenance and checks 41
8.2 Power 43
8.2.1 Introduction 43
8.2.2 Using rechargeable batteries 44
8.2.3 Using non-rechargeable batteries 51
8.2.4 Using the AC adaptor 57
8.2.5 The power management system 58
8.3 The handstrap 61
8.4 The keyboard overlay 63
8.5 Storage 64
8.6 Extending, repairs and internal upgrades 64

Chapter 9 Troubleshooting 65
9.1 Common Problems 65
9.1.1 Programming errors 65
9.1.2 Physical abuse 65
9.1.3 Operation outside specified temperature range 66
9.1.4 Keyboard operation 66
9.1.5 Pressure differences 66
9.2 Diagnosing and Solving Problems 66

9.3 Checks **73**
9.3.1 Communications 73
9.3.2 Real Time Clock (RTC) 73
9.3.3 Files 73
9.3.4 RAM disk 74
9.3.5 Memory configuration 75

Chapter 10 The System Utility (UTIL) 77
10.1 Introduction **77**
10.2 Using the utility **77**
10.3 Set time **78**
10.4 Set date **79**
10.5 Format diskette **79**
10.6 Format fixed disk **79**
10.7 Communication Port 1/2 Setup **81**

Chapter 11 The HOT Key 85
11.1 Introduction **85**
11.2 Status information **86**
11.3 Screen option **86**
11.3.1 Text font 86
11.3.2 Inverse video 87
11.3.3 Split screen 87
11.3.4 Cursor synchronisation 87
11.4 Keyboard option **87**
11.4.1 Backlight timeout 88
11.4.2 Turnoff timeout 88
11.4.3 Autorepeat 88
11.5 Power option **89**
11.5.1 Power remaining 90
11.5.2 Low power warning onset 90
11.5.3 Battery chargeable 90
11.5.4 Battery capacity 90
11.5.5 Charging authorisation 90

Chapter 12 The Editor 91
12.1 Introduction **91**
12.2 Selecting EDIT **91**
12.3 File handling **91**
12.4 EDIT options **92**
12.5 Editing screen **93**
12.6 Facilities **96**
12.7 The commands **98**
12.7.1 Control Keys 98
12.7.2 Function Keys 99

12.7.3 Other Keys 100
BLOCK COPY: Ctrl K C 101
BLOCK DELETE: Ctrl K Y 101
BLOCK MOVE: Ctrl K V 102
BLOCK START/END: Ctrl K B, Ctrl K K 102
BLOCK WRITE: Ctrl K W 103
CHARACTER INSERT: Ins 104
CURSOR KEYS: ↑, ↓, ←, → 105
DELETE FILE: Ctrl K E 105
DELETE LEFT/RIGHT: Backspace, Del 106
DIRECTORY: ☙ 8 106
EXIT: ☙ 2, F2 107
FILE START/END: Home, End 107
FIND: ☙ 3, F3 108
LINE DELETE: Ctrl Y 109
LINE START/END: Ctrl Q S, Ctrl Q D 109
PAGE UP/DOWN: PgUp, PgDn 109
PRINT SCREEN: ☙ 5 110
READ FILE: Ctrl K R 110
REPLACE: ☙ 4, F4 111
SAVE: ☙ 1, F1 112
SET: ☙ 6 112
TAB: Ctrl I 114
UNDELETE: Ctrl U 115
VIEW FILE: ☙ 7 115
WORD DELETE: Ctrl T 116
WORD SKIP: Ctrl A, Ctrl F 116
12.8 Error Messages 118

Chapter 13 Introduction to Communications 121
13.1 Introduction 121
13.2 Communications packages 123
13.3 Background information 124
13.3.1 Buffering 124
13.3.2 Data Transmission 124
13.3.3 Data Reception 125
13.4 Connecting up 125
13.5 Configuring FS/2 communications 126
13.5.1 Handshaking 127
13.5.2 Protocols 128
13.5.3 Port set-up options 131
13.5.4 Communications via charging contacts 140
13.6 Configuring IBM communications 140

13.7 Example communications set-up **141**
13.7.1 Communicating with another FS/2 141
13.7.2 Communicating with a Hunter 16 142
13.7.3 Communicating with an external modem 143
13.7.4 Communicating with an IBM personal computer 144
13.7.5 Communicating with a serial printer 147

Chapter 14 Using Communications 149
14.1 Introduction **149**
14.2 Selecting the communications package **149**
14.3 Starting communication **150**
14.4 Using standard facilities **150**
14.5 Using the COM utility **152**
14.5.1 Setting up 152
14.5.2 Command options 152
14.5.3 Sending a file 153
14.5.4 Receiving a file 153
14.5.5 Examples 153
14.5.6 Error messages 154
14.6 Using the Husky File Transfer Utility, HCOM **154**
14.7 Using the Husky XMODEM Loader, XL **155**
14.7.1 Using XL via Port 1 155
14.7.2 Using XL via the Rack 157
14.7.3 Technical information 157
14.7.4 XL error messages 157
14.8 Using FS/2 applications **159**
14.9 Using MS-DOS applications **159**
14.10 Using MS-DOS communications packages **159**
14.11 Example file transfer **160**
14.11.1 Exchanging files with another FS/2 or Hunter 16 160
14.11.2 Exchanging files with an IBM PC 161
14.11.3 Exchanging files via the FS/2 Communications and Charging Rack 162
14.12 Troubleshooting **162**

Chapter 15 Accessories 164
15.1 Introduction **164**
15.2 Power **164**
15.3 Extra Memory **165**
15.3.1 RAM 165
15.3.2 FLASH EPROM 165
15.4 Software Upgrades **165**
15.5 Communications and Charging Rack **165**
15.6 Communications **166**
15.7 Optical Readers **166**
15.8 Probes and Other Reading Devices **166**

Part 3: Technical Reference

Chapter 16 Introduction 167
16.1 Using this part of the guide 167
16.2 Assumptions 167
16.3 Conventions 168

Chapter 17 Installing Standard Applications 169
17.1 Compatibility 169
17.1.1 Problems with interrupts 170
17.1.2 Problems with fixed disk structure 171
17.1.3 POWER BASIC 172
17.2 Porting the application 172
17.3 Configuring 173
17.4 Testing 175
17.5 FS/2 operating system and utilities 175
17.6 Special considerations 176
17.6.1 Batteries 176
17.6.2 Display 177
17.6.3 Training 177

Chapter 18 Adapting Applications 179
18.1 Using PC-DOS or MS-DOS software 179
18.2 Using BASIC software 179
18.3 Using Hunter 16 software 181

Chapter 19 The Interrupts 183
19.1 Summary 183
19.2 BIOS interrupts 186

Chapter 20 INT 05H, Print Screen Contents 189
Chapter 21 INT 10H, Screen Handler 191
Set screen mode 193
Set cursor size 193
Move cursor 194
Get cursor position 194
Get cursor address [+] [-] 194
Set display page 195
Scroll up 195
Scroll down 195
Read character and attributes 196

Write character plus attributes 196
Write character 197
Write pixel 197
Read pixel 198
Write character as TTY 198
Get video state 198
Write string [-] 198
Set graphics font [+] 199
Move cursor to graphics co-ordinates [+] 200
Get cursor position in graphics co-ordinates [+] 201
Set contrast [+] 201
Get/set backlight timeout [+] 201
Split display [+] 202
Draw ellipse/circle [+] 202
Draw line/box [+] 203
Select inverse video mechanism [+] 204
Select text font [+] 204
Set LCD window position [+] 206
Zoom [+] 206
Looking keys [+] 206
Get graphics font [+] 207
Turn backlight on/off [+] 207
Reset screen parameters [+] 207
Get contrast and backlight state [+] 208
Set bold attribute mask [+] 208

Chapter 22 INT 11H, Check System Equipment 211
Chapter 23 INT 12H, Check Memory Size 213
Chapter 24 INT 13H, Disk Handler 215
Reset disks 217
Read disk status 217
Read sectors 217
Write sectors 218
Verify sectors 218
Format track [-] 219
Read current drive parameters [+] 220
Get disk type [+] 220

Chapter 25 INT 14H, Serial Port Handler 221
Initialise port 223
Send character 225
Input character 225
Check status 225

Extended initialise port [+] 225
Read comms parameters [+] 227
Select comms parameters [+] 230
Extended control [+] 234
Extended status [+] 235
Control handshake lines [+] 235
Control CTS [+] 236
Control RS232 drivers [+] 236
Control RI power up [+] 237
Get installed protocols count [+] 237
Get protocol name [+] 237
Get protocol handle [+] 237
Extended protocol menu [+] 238
Get extended protocol parameters [+] 238
Get/set DTR [+] 238
Set comms level [+] 239
Detect RACK [+] 239
Select RACK communications mode [+] 239
Select modem communications mode [+] 240
Set or clear COM1 Tx bit [+] 240
Control COM1 input buffering [+] 241
Control 8250 emulation [+] 241

Chapter 26 INT 15H, BIOS Extension Functions [+] 243

Set clock speed [+] 246
Get power level (APM) [+] 246
Set low power threshold (APM) [+] 246
Get/set idle timeout [+] 247
Control Resume mode [+] 247
Authorise charging (APM) [+] 248
Set battery level (APM) [+] 250
Control STOP mode [+] 250
Power down [+] 251
Control power down [+] 251
Control SLOW mode [+] 252
Get ROM BIOS version number [+] 252
Get serial number [+] 252
Get event details [+] 253
Enable/trap event [+] 254
Acknowledge event [+] 255
Control sound [+] 256
Power up keys [+] 256
Redirect serial number [+] 257
Set backlight power up state [+] 258
Set contrast power up state [+] 258

Control power save [+] 258
Get DOS RAM [+] 259
Set DOS RAM [+] 259
Redirect LPT1 [+] 260
Invoke HOT key [+] 260
Control HOT key [+] 260
Control HOT key power option [+] 261
Override low power turn off [+] 261
Control battery change facilities (APM) [+] 262
Get/set battery type (APM) [+] 263
Set battery capacity (APM) [+] 263
Control power output [+] 264
Sound output [+] 265
Control screen synchronisation [+] 266
Set/restore power menu (APM) [+] 267
Get/set screen attribute table [+] 267
Set INT 72H vector [+] 268
Get power up keys [+] 269
Get/set power management mode [+] 269
Control power input (SPM) [+] 270
Set charger temperature override [+] 270
Get/set power save entry flag [+] 271
Get/set boost charge (SPM) [+] 272
Get/Set volume level [+] 273
Set power out mark/space duration [+] 273
Get charging status [+] 273
Reset machine information [+] 274
Get machine information [+] 274
Control/monitor fast discharge [+] 275
Get/set fast discharge temperature override [+] 275
Select soft/default font [+] 276
Get unit serial number [+] 277
Get customer id [+] 278
Resynchronise system clock with RTC [+] 278

Chapter 27 INT 16H, Keyboard Handler 280

Get key 281
Get status 281
Get shift status 282
Set key repeat 282
Write to buffer 283
Extended get key 283
Extended get status 284
Extended get shift status 284
Set temporary shift [+] 285
Control shift keys [+] 285

Control Ctrl-Alt-Del [+] **286**
Control emergency breakout [+] **286**
Redefine key codes [+] **287**
Reset keyboard [+] **288**
Control keyclick [+] **288**
Control screen dump area [+] **288**
Get key repeat [+] **289**
Control key repeat [+] **289**
Redefine key scan codes [+] **290**
Redefine PAW key codes [+] **290**
Control Break keys [+] **291**
Select keyboard [+] **291**
Reset extra keyboard variables [+] **292**
Clear keyboard buffer [+] **292**

Chapter 28 INT 17H, Printer Control 293
Print byte **294**
Initialise printer **294**
Get printer status **294**

Chapter 29 INT 19H, Reboot 295
Chapter 30 INT 1AH, Clock Handler [+] 297
Get system clock **298**
Set system clock **298**
Get RTC time [+] **298**
Set RTC time [+] **299**
Get RTC date [+] **299**
Set RTC date [+] **299**
Set RTC alarm [+] **300**
Disable RTC alarm [+] **300**
Get RTC alarm time [+] **300**

Chapter 31 Hardware 303
31.1 Organisation **303**
31.2 Memory maps **304**
31.2.1 Logical memory map 305
31.2.2 Physical memory map 306
31.2.3 I/O addresses 306
31.3 Hardware interrupts **311**
31.4 Device details **312**
31.4.1 CGA and 6845 emulation (display) 313
31.4.2 8255 emulation (various uses) 317
31.4.3 8253 emulation (timers) 319
31.4.4 Serial Ports 321
31.4.5 Parallel printer port 328

31.4.6 8237 emulation (DMA controller) 328
31.4.7 8259 emulation (Interrupt controller) 329
31.4.8 Disk controllers 332

Chapter 32 Using Power Handling 333
32.1 The facilities **333**
32.1.1 Power-up 333
32.1.2 Power-down 335
32.1.3 Power monitoring and charging 337
32.1.4 Saving power 340
32.1.5 Power output 343
32.1.6 Calculating power usage 343
32.2 Using the facilities **344**
32.2.1 Setting up 344
32.2.2 Using SLOW mode 346
32.2.3 Charging NiCad batteries 347
32.2.4 Using fast discharge 347

Part 4: Appendices

Appendix A Specification 353
A.1 Physical **353**
A.2 Fascia **354**
A.3 Programming **355**
A.4 Communications **356**
A.5 Screen **357**
A.6 Memory **358**
A.7 Clock/calendar **358**
A.8 Microprocessor **358**
A.9 Batteries **359**

Appendix B Operating Environment 360
B.1 Operating Temperature **360**
B.2 Humidity **360**
B.3 Waterproofing and Dustproofing **360**
B.4 Storage Conditions **361**
B.5 Electromagnetic Compatibility **361**
B.6 Resistance to Shock, Vibration and Impact **361**
B.7 Resistance to Pressure and Elevation **362**

Appendix C Character Set 363

Appendix D Hexadecimal to Decimal Conversion 364

Appendix E Keyboards 365
E.1 Keyboard layouts 365
E.2 Key matrix codes 368
E.3 Scan codes 369

Appendix F Interfacing 375
F.1 12-way connectors (Port 1 and Port 2) 375
F.2 25-way D type (Port 1 and Port 2) 378
F.3 9-way D types (Port 1 and Port 2) 379
F.4 5-way FISCHER (AC adaptor) 380
F.5 Modem option (COM1) 381
F.6 Communications and charging contacts (COM1) 381

Appendix G BIOS Revisions 383
G.1 Version 1.0 383
G.2 Version 1.10 383
G.3 Version 1.20 383

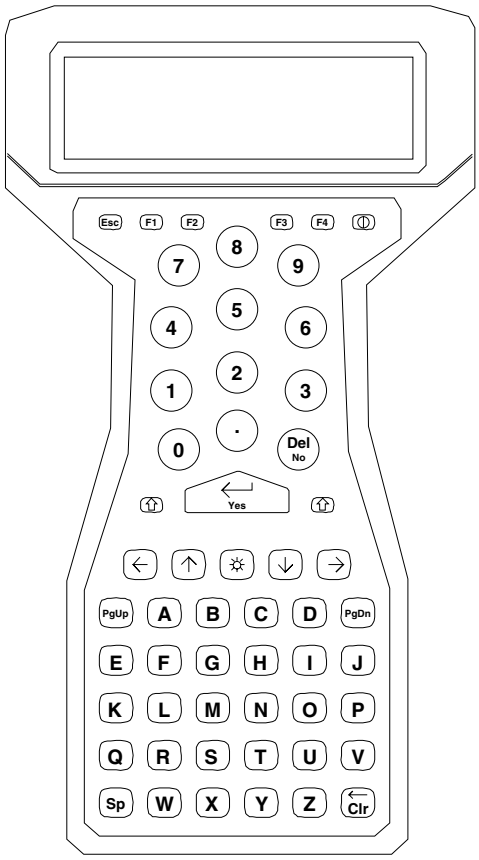
Appendix H The Husky Oracle GT 385
H.1 Introduction 385
H.2 Formatting diskettes 385
H.3 Rebooting with the Oracle GT 386
H.4 Recovering from drive C corruption with the Oracle GT 386
H.5 Loading applications with the Oracle GT 387
H.6 Programming the Oracle GT 387
H.6.1 INT 13H 387
H.6.2 INT 15H 390
H.6.3 INT 19H 391

HUSKY FS/2

Part 1
Introduction

Chapter 1 Welcome to the Husky FS/2

Throughout this publication, the term **FS/2** means the **Husky FS/2**.



Husky Computers' **FS/2** (Field System 2) is a small but tough MS-DOS computer.

Highly resistant to moisture, dust, vibration, shock and electromagnetic interference, it should provide you with long and trouble-free operation.

It is a product of many years' experience developing portable computers. If you have any problems or queries, consult the supplied guides first.

If you need more help, please contact your supplier or **Customer Support** at Husky Computers.

The **FS/2** is a practical tool for use in some of the most demanding environments.

CAUTION: Hazardous voltages inside. Do not attempt to open the FS/2. There are no user serviceable parts inside. Opening the case may damage the seals.

1.1 The FS/2 system

The **FS/2** is a complete, ready to use system, consisting of:

- The **FS/2** with its standard software
- A set of batteries
- A backstrap
- This guide (the *Husky FS/2 System Developer's Guide*)
- The *FS/2 User Leaflet*, for end users

Additional manuals on specific aspects of the system are also available from Husky Computers or your local distributor. These consist of:

- *Application Notes*, which cover use of the **FS/2** with other peripherals
- The *GWBASIC User's Guide*
- The *MS-DOS Programmer's Manual*
- The *MS-DOS User Reference*

1.2 Features

Measuring just 236 x 128 x 43 mm (9.29" x 5.03" x 1.69") maximum and weighing 750 g (about 26 oz) including batteries, the **FS/2** is a completely self-contained powerful computer, small enough to hold in one hand and carry all day.

The **FS/2** can operate all day from internal batteries and is sealed against moisture, dust and other hazards, so you can take it with you and use it almost anywhere.

It includes MS-DOS in ROM, and (within the constraints of a low power hand-held computer) the hardware architecture is generally PC-compatible. This means that **FS/2** can run a wide range of software.

You can also program the **FS/2** using your usual PC-compatible assembler or other language, or the supplied BASIC. Assembly language access allows full use of its many specialised features.

Data and programs can be exchanged easily with other PC compatible computers by using the built-in communications utility (HCOM).

The **FS/2** can be fitted with a range of RAM sizes, to suit the user's needs. This RAM can be split into main (DOS) memory and RAM disk.

The RAM disk is configured as drive C and can be used to store data and program files. Since its contents are preserved even while turned off, this provides the advantages of a built-in hard disk, without the disadvantages of extra weight, cost or fragility.

1.3 Options

The **FS/2** may also be fitted with a number of internal and external options, to provide a versatile system. These options include:

- neck strap
- carry case
- plug-in AC adaptor (charger)
- integral modem
- plug-in external serial RAM cartridges
- rugged serial connectors
- bar code wands and scanners
- meter reading probes
- additional RAM
- additional FLASH EPROM

Chapter 2 The FS/2 Guides

The standard **FS/2** documentation consists of the following guides:

FS/2 User Leaflet	Tells an operator how to use and look after the **FS/2**. You will also need to tell the operator how to use the application which you install on the **FS/2**. You may also want to provide the operator with more information (such as how to change batteries), if they have to cope with such situations on their own.
Husky FS/2 System Developer's Guide	Technical information, for the personnel who maintain and develop software for the **FS/2**. It: ● Introduces you to the **FS/2**. ● Explains how to set up, maintain, fault-fix and expand the **FS/2**, including details of commands which are not provided by a desktop MS-DOS computer. ● Provides additional technical information that you will need to write or adapt programs for the **FS/2**, concentrating on details that are different to a desktop MS-DOS computer.
The MS-DOS User's Reference	This provides an introduction to MS-DOS and detailed information on using it, applicable to any computer using MS-DOS (including the **FS/2**).
The MS-DOS Programmer's Manual	This provides detailed technical information applicable to any computer using MS-DOS (including the **FS/2**).

The GWBASIC User's Guide — This describes how to use the supplied industry-standard programming language, GWBASIC. This can be used to write or run programs for use on the **FS/2** or other computers running MS-DOS.

This is the *FS/2 System Developer's Guide*.

The technical information is provided in two separate guides for a number of reasons. For example, if you already know how to write programs for MS-DOS computers, you need only refer to the *FS/2 System Developer's Guide* (this guide) for a description of the extra facilities provided. Or, if you want to write programs to use on the **FS/2** as well as on conventional MS-DOS computers, you should only use those facilities described in the *MS-DOS Programmer's Manual*.

If you require an introduction to using standard MS-DOS suitable for new users, the *MS-DOS User's Reference* is also available from Husky Computers.

Chapter 3 Using this Guide

3.1 Structure

This guide is divided into four main parts:

Part 1: Introduction	A brief introduction to the **FS/2** and this guide, that you should read first.
Part 2: Setting Up	Details of the commands and operating procedures which you will need to set up and maintain the **FS/2**. If you are not already familiar with MS-DOS you may also need to read the *MS-DOS User's Reference*.
Part 3: Technical Reference	Technical information for programmers, describing the overall structure, software interrupts available, hardware interrupts used and device emulations. You should read this in conjunction with the *MS-DOS Programmer's Manual* if you are not already familiar with programming under MS-DOS 3.3. You may also need to refer to hardware descriptions (such as the IBM PC-XT Technical Reference) if you are not familiar with IBM PC hardware.
Part 4: Appendices	Summary technical data, for ease of reference.

There is also a detailed index, at the end of the guide.

3.2 Suggested reading approach

Whatever your interests, you should start by reading the rest of this part of the guide (Introduction). Then:

To learn about:	**See:**
Setting up the **FS/2**	Chapter 5.
Using and maintaining the **FS/2**	The *FS/2 User Leaflet* and chapters 7 to 9 of this guide.
An introduction to MS-DOS	The *MS-DOS User's Reference.*
The standard MS-DOS commands	The *MS-DOS User's Reference.*
The extra **FS/2** commands	Chapters 10 to 12.
Installing an application	Chapter 17 and the application's installation instructions.
Connecting a peripheral	Chapter 13 and Appendix F.
Writing software for the **FS/2**	Chapters 19 onwards and the *MS-DOS Programmer's Manual.*
Adapting MS-DOS software for the **FS/2**	Chapter 18.
Programming in GWBASIC	The *GWBASIC User's Guide*.

3.3 Conventions

Throughout these guides, a few simple conventions are used to help clarify descriptions. These are mainly used to indicate text to type, as follows.

`DIR`	this is text which should be typed exactly as shown. If you prefer, you may type it as the equivalent small letters (d i r).
`filename`	this is a description of text to type, rather than the actual characters. In this case, you should type the name of a file (for example, PROGRAM1).

⏎ ⇦	this is a name or symbol representing the key that you should press or hold down. In most cases, the name or symbol is the same as appears on the key.
[,A]	this is an optional part of the text ie text which may be omitted or typed, depending on what you want to do.
Enter new date	text as it appears on the screen

These conventions are often used in combination. For example:

DIR [*filename*] ⏎	means type D I R and then a space, then either press the ⏎ key, or type the name of a file and press ⏎.

HUSKY FS/2

Part 2
Setting Up

Chapter 4 Introduction

This part of the guide describes:

- How to unpack, check and set up the **FS/2** to run an application. (Chapter 5.)
- The information and hardware to give a user. (Chapters 6 and 7.)
- How to keep the **FS/2** running smoothly, including how to diagnose and fix common problems. (Chapters 8 and 9.)
- How to use the special **FS/2** utilities and keys. (Chapters 10 to 12.)
- How to use communications to load applications and data to or from the **FS/2**. (Chapter 13 and 14.)
- The accessories available for the **FS/2**. (Chapter 15)

For information on using standard MS-DOS commands, see the *MS-DOS User's Reference.* For information on programming the **FS/2**, see Part 3. For information on programming with MS-DOS, see the *MS-DOS Programmer's Manual.*

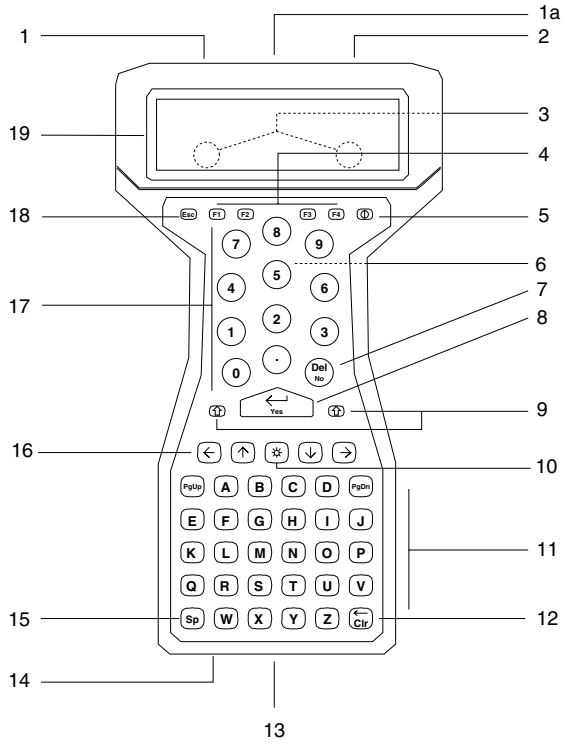
If you've used a desktop MS-DOS computer before, you'll find using the **FS/2** quite similar, but with a number of important differences. Some are fairly obvious: like the portability, small size and different keyboard layout. Other differences are more subtle but very useful. For example, if you turn off while using an application, when you turn on again the **FS/2** will carry on running the application as if nothing had happened.

Chapter 5 Setting Up

This chapter briefly describes how to set up the **FS/2** to run an application. You may also need to refer to Chapter 7 for more details of how to turn on and off, reboot and use the main controls. You will need this information yourself and may need to pass some of it on to the operators using the **FS/2** in the field.

5.1 About the FS/2

There are several variants of the **FS/2** which differ mainly in the connectors fitted to the top of the unit.



Keyboard and connector layouts may vary on certain models.

1 PORT 1 CONNECTOR: main serial port (12-way or 9-way).

2 PORT 2 CONNECTOR: second serial port (12-way or 9-way as per PORT 1).

1a Alternatively, on some models a single 25-way connector is provided, combining PORT 1 and PORT 2.

3 CONTACTS: *on the rear of the unit*, these connect to the **FS/2 Communications and Charging Rack**, if this ***option*** is fitted.

4 FUNCTION KEYS: press to use application functions.

5 POWER KEY: press to turn on or off.

6 HANDSTRAP: *on the rear of the unit*, this helps you hold the **FS/2** securely.

7 DEL/NO KEY: press to delete entries or answer No to a question.

8 ENTER/YES KEY: press to complete typing, type a carriage return, or answer Yes to a question.

9 SHIFT KEYS (⇧): hold either down to type the characters (or functions) shown above the keys.

10 BACKLIGHT KEY: press to illuminate the screen for use in low light. This key can also be configured (under software control) as the Husky "PAW" key, which provides access to a range of special functions.

11 TYPING KEYS: type letters, or symbols and functions when used with ⇧ (SHIFT).

12 BACKSPACE KEY: press to erase typing.

13 BATTERY CAP: remove to change batteries.

14 PORT 3 CONNECTOR: serial port also used for connecting the **FS/2 AC Adaptor**.

15 SPACE KEY: types a space (blank) character.

16 CURSOR KEYS: move the cursor.
SHIFT ↑ and SHIFT ↓ adjust screen contrast.

17 NUMERIC KEYPAD: type numbers.

18 ESCAPE KEY: usually used to cancel a function.

19 LCD SCREEN: displays prompts and messages and information as you type.

Note that the **FS/2** is normally supplied with the ☼, PgUp and PgDn keys configured to operate as PAW, CTRL and ALT.

5.2 Fitting batteries

FS/2 is normally supplied fitted with alkaline batteries, but if not or you need to change them, you will need three AA-size alkaline batteries or three A-size NiCad rechargeable batteries. If you are fitting AA-size batteries, use the battery packing tube supplied with **FS/2**. If you are using NiCad batteries you must use A-size (not AA-size); we recommend you use the **FS/2 Battery Stick** or Husky-approved NiCads. See section 8.2.2 for information on setting up for rechargeable batteries.

CAUTION: Do not mix batteries of different types, sizes, or states of charge. DO NOT FIT LITHIUM BATTERIES UNDER ANY CIRCUMSTANCES.

We do not recommend use of the cheaper Zinc-Carbon batteries for routine operation, as they may leak (damaging the **FS/2**) and have shorter lives. You may however use such batteries for short periods, in an emergency.

To fit the batteries:

- **Turn off.**
- Use a COIN to undo the battery cap.
- Feed in the cells carefully, **positive end first**. If you are fitting AA-size batteries, insert them in the battery packing tube supplied with the **FS/2**.
- Take the battery cap and, with finger pressure only, press it into the battery compartment and turn it clockwise.
- Only after the thread is started, use a coin to screw the cap tightly home.

If you prefer, you can operate the **FS/2** from the **FS/2 AC Adaptor** when portability is not required, **provided that the unit is fitted with rechargeable batteries**. See section 8.2.4 for details.

If the **FS/2** has been stored without any batteries for a long period, the internal backup battery (used to protect the contents of the RAM disk) may be flat. This will begin trickle charging when you fit batteries but may take up to approximately 28 days (if the backup battery is totally flat and the **FS/2** is turned off). If you need to charge the backup battery faster than this, ask your supplier for the FLASHBAK utility.

5.3 Turning on

To turn on, press the ⓘ key firmly.

5.3.1 Turning on for the first time

If you are turning on for the first time you should see a screen like this:

This is the 'Welcome' screen, which shows that the **FS/2** is starting up for the first time (or has been reset). Press any of the 'normal' keys (such as Ⓐ or ⏎) to load MS-DOS. This is also known as a 'cold start'.

Note that the Welcome screen can be disabled. If it is, the MS-DOS prompt will be displayed initially, without having to press any keys first.

Since there is no AUTOEXEC.BAT file, MS-DOS will prompt you for the date and time, by displaying a prompt like this:

```
Current date is Tue 1-01-1980
Enter new date (mm-dd-yy):
```

Type the date in the indicated format and press ↵ and you will be prompted for the time, something like this:

```
Current time is  0:00:01.00
Enter new time:
```

Type the time now (in the format hh:mm or hh:mm:ss, 24 hour clock) and press ↵.

If you are not going to set up now, turn off by pressing ⏻ again, to conserve power.

5.3.2 Turning on at other times

Normally, when you turn on the **FS/2** will continue with what it was doing when last turned off, as if you had never turned off. This is quite unlike a conventional desktop computer, which reboots each time it is turned on.

If you cannot see anything on the screen, you may need to adjust the screen contrast. This is particularly likely if the **FS/2** has previously been used in much warmer or colder conditions. Hold down the ⇧ key and press ↑ or ↓ until the screen is clearly visible. If this does not help, the batteries may be run down, or there may be something wrong with the **FS/2**: see Chapter 9.

5.4 Configuring the FS/2

5.4.1 Power management

The **FS/2** provides two power management modes: Standard Power Management (SPM) and Advanced Power Management (APM), which differ in the way that power is monitored and low power situations are handled:

- In SPM, the **FS/2** monitors the battery voltage level, and if this drops below a threshold, it will display low power warning messages and turn off to conserve the remaining power for storing the application and data on the RAM drive.

- In APM, the **FS/2** monitors power usage and charging. It will display low power warnings if it calculates that the remaining battery capacity is below a threshold (eg 5%), and provides additional mechanisms for controlling charging.

In both modes, if the battery level falls so low as to endanger the memory contents, the **FS/2** hardware will turn off to preserve the memory (without displaying a warning message).

The **FS/2** is normally supplied fitted with alkaline batteries and with APM mode selected, set up as follows:

Power remaining:	90% or more
Low power warning onset:	5%
Battery chargeable:	No
Battery capacity:	1800 mAh
Charging authorisation:	1 (disabled)

To change the power mode or APM settings, see section 8.2, unless the application does this for you. For further background on power monitoring, see section 8.2.5.

5.4.2 Time and date

If you got the time or date wrong when you turned on for the first time, you can correct them by using the TIME or DATE commands (see your MS-DOS manual), or by using the system utility UTIL (see sections 10.3 and 10.4).

5.4.3 Ports

If you are going to use a serial port (eg to load the application from a desktop PC), set it up to suit the connected device, as described in Chapter 14. (If an application is going to use serial ports, it should set them up itself.)

5.4.4 System files

Just like any MS-DOS computer, many aspects of operation of the **FS/2** can be configured by creating (or editing) text files called CONFIG.SYS and AUTOEXEC.BAT (in the root directory of drive C) and rebooting.

The easiest way to create or edit these files is to use the built-in text editor EDIT (see Chapter 12) or to create the files on a PC and download them to the **FS/2** (see Chapter 14).

The **FS/2** does not have any special requirements in this area, so simply create files the way you would on any PC. You may however prefer to use a small value for BUFFERS, since the **FS/2** RAM disk is fast enough not to need additional buffering.

One of the **FS/2**-specific commands you may want to include in AUTOEXEC.BAT is the Husky International Keyboard Program, I.COM, described in the next section.

CAUTION: Do NOT run KEYB.COM or include a KEYB command in AUTOEXEC.BAT! Use I.COM if you require support for a non-English keyboard.

5.4.5 International keyboards

FS/2 is available with a number of different keyboard layouts to cater for different requirements. Support for non-English keyboard layouts is provided by a simple utility called I.COM.

To use I.COM, simply type `I` and press ⏎. This will display a menu like this:

```
Version x.x
FS/2 International Keyboard Program

Select option number to install :-
  0 (Reset)  1 (German)  2 (Swedish)
  3 (Danish) 4 (TDS)
Or any other key to abort
```

Press the number key which corresponds to the unit's keyboard layout, or any other key to quit without changing the keyboard. `0` resets the keyboard definition to the default (American English) one. The keyboard redefinition happens immediately and will remain in force until the **FS/2** is rebooted.

To make the keyboard definition "permanent", add a command to AUTOEXEC.BAT to run I.COM with the appropriate number. For example, to select a German keyboard layout, add `I 3`.

5.4.6 Rebooting

To reboot, hold down Ctrl, Alt and press Del simultaneously, then release all three keys. Normally, the welcome message will be displayed; press any normal key (eg ↵) and the DOS prompt should be displayed (or a date prompt, if there is no AUTOEXEC.BAT file). You are now ready to install the application.

5.5 Installing the application

5.5.1 Copying the files

While you can develop applications on the **FS/2** (eg using GW-BASIC), they will typically be developed and stored on a desktop PC, or provided on a PC-compatible diskette.

To use the application on the **FS/2**, copy the application program and data files from the PC to an appropriate directory on the **FS/2 C drive.** Note that you cannot copy files to the DOS directory, as this is stored in ROM (you will get a write protect error). Copy the file by using communications, eg by using the supplied utilities (COM, HCOM or XL). For details, see Chapter 14.

5.5.2 Setting up the application

If you created a new directory for the application, operation will probably be simpler if you add that directory to the PATH statement in AUTOEXEC.BAT.

If the application requires changes to CONFIG.SYS or AUTOEXEC.BAT, make them now (see section 5.4.4) and then reboot to bring the changes into effect. For example, the application might require a higher FILES figure (CONFIG.SYS) or be designed to run from AUTOEXEC.BAT.

5.5.3 Running the application

As a final step, make sure that the application runs correctly!

If it does not, find out what is stopping it. To exit the application or reboot you may need to use emergency breakout or a hard reset (see section 9.2), as some applications will disable Ctrl-Alt-Del reboot.

Chapter 6 Issuing the Unit

Once you are satisfied that the **FS/2** and installed application work correctly, you can give the unit to its intended user. Most applications are designed to 'lock in' the user ie to prevent the user exiting the application and deny them access to facilities which they do not need. Before issuing the **FS/2**, make sure that it is set up correctly and that the application is running.

You may also want to provide other items, such as:

- The *FS/2 User Leaflet*, which describes how to operate the **FS/2**.
- Instructions (or training) on using the application which you have installed.
- Spare batteries.
- The **FS/2 AC Adaptor**, if you have fitted rechargeable batteries. **Warn the user not to attempt to use the adaptor if they fit non-rechargeable batteries.**
- Accessories, such as neck and wrist straps.
- Any peripherals required by the application, such as barcode wands or meter reading probes, with instructions (or training) on how to use them.

If the unit is being taken on an airline trip, loosen the battery cap to avoid pressurisation problems. At all other times, make sure that the battery cap is tight, to avoid the ingress of dust or damp.

Chapter 7 Using the FS/2

This chapter describes in detail how to operate the **FS/2** ie how to use the keyboard, screen, and main controls. This information is more detailed than that in the *FS/2 User Leaflet*, with emphasis on the default (developer) keyboard, and the DOS environment. It is mainly intended to help you set up and maintain units, but may also help you to help users who need more guidance.

7.1 Turning on and off

To turn on, press ⏻ and the **FS/2** should turn on, beep, and carry on execution from where it was turned off. If it will not turn on, check the screen contrast (see section 7.3.2) and batteries. If you suspect that an application has locked up, use emergency breakout: see Chapter 9 for details.

To turn off, press the ⏻ key firmly. You should turn off whenever you are not going to be using the **FS/2**, even if it's just for a few minutes, as this will help extend battery life.

The **FS/2** will also turn **itself** off, if:

- the battery power is low, OR
- you haven't touched any of the keys for a while and it is not using its serial ports, OR
- an application is running which tells it to turn off

Again, you can just turn on again and carry on working as if nothing had happened, when you want.

7.2 Rebooting

As already mentioned, the **FS/2** does not reboot each time it is turned on, but continues execution from the point where it was turned off. This makes operation very convenient, but there will be times when you **want** to reboot. For example, if you change C:\CONFIG.SYS (eg add a device driver), you must reboot to bring the changes into effect.

To reboot, press Ctrl Alt Del. This displays the 'Welcome' screen:

Press any of the 'normal' keys (such as ⏎) and the **FS/2** will perform a normal MS-DOS boot, configuring the system as specified by the CONFIG.SYS file and executing the commands in the AUTOEXEC.BAT file (in the root directory of drive C).

If an application has disabled Ctr-Alt-Del, you cannot reboot in this way and must instead use the emergency breakout method, described in Chapter 9.

Depending on how the **FS/2** is set up, this may start an application automatically, or take you to MS-DOS command mode, for you to use MS-DOS commands or run applications by typing the appropriate commands. (If you want to leave the application, you should have been provided with instructions on how to do this. If not, see Chapter 9.)

7.3 The screen

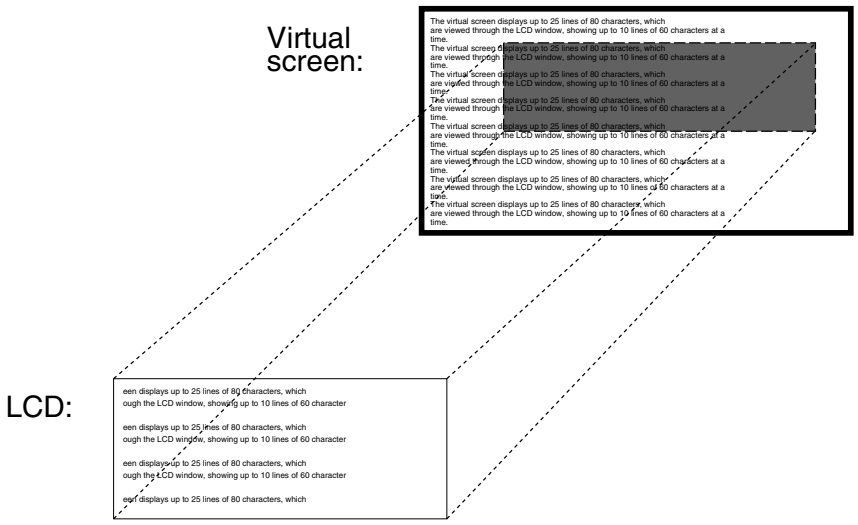
7.3.1 Introduction

The **FS/2** has a large LCD (liquid crystal display) screen, which can show up to 10 lines of 60 characters and pictures using a grid of 240 by 64 dots.

The screen is protected by a tough, scratch-resistant plastic window. However, it can be scratched if mistreated, so please take care.

Because the LCD display works by contrast, rather than by emitting its own light, it is perfectly visible no matter how bright the light is. In bad light, the backlight provides excellent visibility.

The screen behaves as a ‘window’ onto a larger ‘virtual’ screen, which emulates the IBM CGA (colour graphics display adaptor) ie provides 25 lines of 40 or 80 characters (text modes) or 320x200 or 640x200 pixels (graphics modes). (For more detailed information, see Part 3.)



Applications can use the display exactly as if it were a full size IBM CGA screen. The LCD screen ‘window’ moves over the virtual screen automatically, to show the most recent output (eg a prompt waiting for input, or your typing). You may also control it by using special keys (see section 7.3.3).

7.3.2 Visibility

The LCD screen gives good results in most lighting conditions. For use in poor light, there is a backlight.

To adjust the LCD screen for maximum clarity, place it at the angle you will be working, then:

- if you are using the default keyboard, hold down the ⓕ key and press ⓤ or ⓓ. Release both keys when the display appears clearest.
- if you are using the user keyboard, hold down either ⓢ key and press ⓤ or ⓓ. Release both keys when the display appears clearest.

To improve visibility in bad light, turn on the backlight:

- if you are using the default keyboard, hold down the ⓕ key and press ⓛ
- if you are using the user keyboard, press ☼

To turn the backlight off, press the same key(s) again. The backlight places an additional drain on the batteries, so only use it for short periods.

To maintain legibility, wipe the screen with a clean cloth. Do not use solvents or abrasives as they might damage the screen. Do not leave the screen in bright sunlight for long periods, particularly inside a vehicle.

7.3.3 Moving around the virtual screen

The virtual screen provides a CGA-compatible screen, allowing up to 25 lines of 80 characters and graphics with resolutions up to 640x200 pixels. The LCD provides a window onto this virtual screen, which can display up to 10 lines of 60 characters, or 240x64 pixels.

The window moves over the virtual screen automatically to show the most recent keyboard input. If you are using the default keyboard, you can also move the window manually, by pressing the 'viewing keys':

- To 'flip' the window to show the other side of the virtual screen, hold down the ⓕ key and press ⓕ. (This is the LCD flip key.)
- To move the window a line or column at a time, hold down ⓕ and press one of the cursor keys. (These are the LCD looking keys.)

If you are using the user keyboard, use the cursor keys as LCD looking keys.

The window will return to its original position as soon as you type something.

7.3.4 Screen map key

If you are using the default keyboard, to display the contents of the full screen, hold down ⓕ and press Ⓜ. This displays a pixel on the LCD screen for each non-space character (if in text mode) or group of 4x4 pixels which are set to black (if in graphics mode).

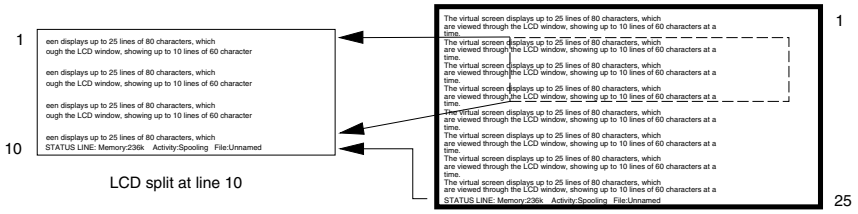
To return to the normal LCD contents, press the same keys again.

7.3.5 Split screen

Many standard applications use a particular screen line (usually the top or bottom line) for status information and the rest for the information which is being entered or displayed. As the LCD screen shows whichever part of the full screen is being updated, this could lead to a lot of distracting screen movement.

To help prevent this, you can split the virtual screen into two parts, and display each in a separate part of the LCD screen. Each part of the LCD can either be fixed in position or scrolled to show output in the corresponding part of the virtual screen.

For example, if your application uses line 25 as a status line, you could split the virtual screen at line 25, and split the LCD screen at line 10:

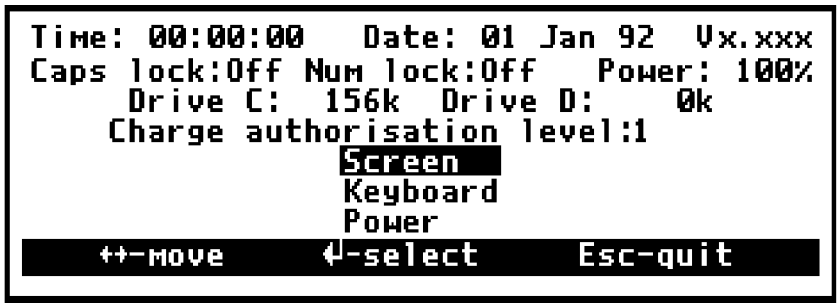


LCD split at line 10

CGA split at line 25

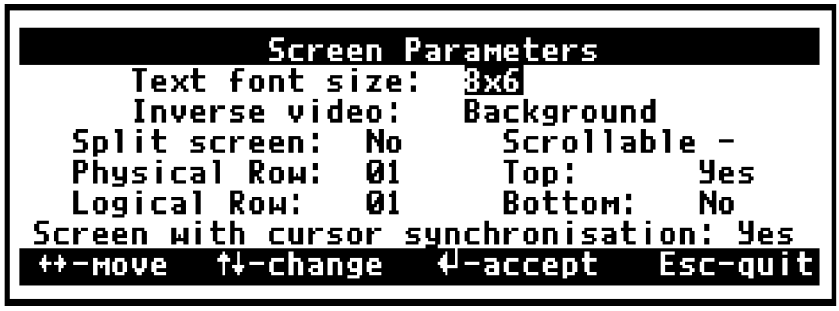
The top nine lines of the LCD could be set to scroll (to show data input/output), while the bottom line could be set to fixed (to show the status line).

To do this, press the HOT key (ⓕ Ⓗ), and you'll see a screen like this:



The last line of the screen indicates the keys you can use. The current selection (**Screen**) is highlighted (in reverse).

If the **Screen** option is not highlighted, move to it by using the ⇦ or ⇨ key. Press ↵ to select it and you'll see a screen like this:


Screen Parameters
Text font size: 8x6
Inverse video: Background
Split screen: No Scrollable -
Physical Row: 01 Top: Yes
Logical Row: 01 Bottom: No
Screen with cursor synchronisation: Yes
↔-move ↑↓-change ↵-accept Esc-quit

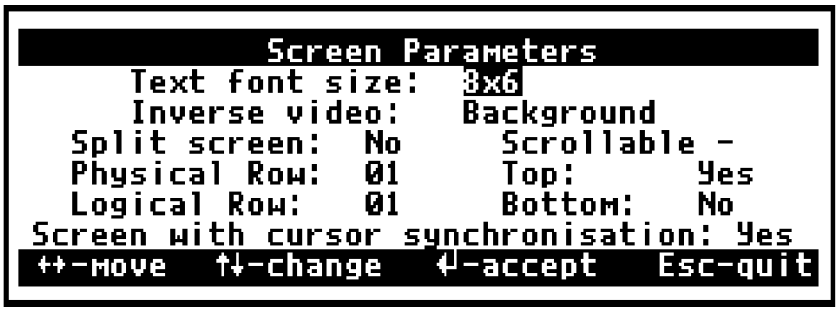
Move the highlight to the options you want to change by using the ⇦ and ⇨ keys, then adjust the display value by pressing ⇧ or ⇩ key. The 'physical row' is the row at which to split the LCD. The 'logical row' is the row at which to split the CGA. When the screen is split as you want it, press ↵ and then Esc to leave the HOT key.

7.3.6 Inverse video

The IBM CGA screen (which the **FS/2** emulates) can display text with a wide range of attributes, including foreground (text) colour (red/green/blue) and intensity, background colour (red/green/blue) and blinking. These attributes are typically used to highlight options or important messages, or for purely decorative purposes.

The **FS/2** screen is monochrome and cannot display colours. It can however display text as reverse video (white on a black background) and you can choose to use this to emulate some of the other text attributes.

To change the way reverse video is used, select the default keyboard and press the HOT key (⊞ H), make sure the highlight is on the **`Screen`** option (if not, use ← or → to put it there), then press ↵. You'll see a screen like this:



Move the highlight to the **`Inverse video`** option with the ← and → keys, then adjust the displayed value by pressing ↑ or ↓ key. The options are as follows:

`Background` Use inverse video for text with a background colour other than black.

`Intensity` Use inverse video for high intensity (bright) text.

`High Back` Use inverse video for text with a high intensity (bright) background.

`Int/Backgd` Use inverse video for text with a high intensity (bright) text or background.

`None` Do not use inverse video.

`Monochrome` Use inverse video for text with a black foreground and a white background (as on an IBM monochrome display adaptor).

When you've set inverse video as you want it, press ↵ and then Esc to leave the HOT key.

If you have problems reading the screen, try changing the inverse video method to get the best effect.

7.4 The keyboard

7.4.1 Introduction

The keyboard is used for typing and to control the **FS/2**.

Typing is provided by letter keys organised in an alphabetical layout, with separate numeric keypad and cursor key clusters. Symbols and punctuation are provided by SHIFT plus letter keys. This provides access to all the functions that you are likely to need, although applications can also redefine any of the keys to provide access to other functions, if required.

Three keys on the keyboard can operate in two different modes:

Key legend	In mode 1	In mode 2
☼	PAW key	Controls backlight
PgUp	Ctrl	PgUp
PgDn	Alt	PgDn

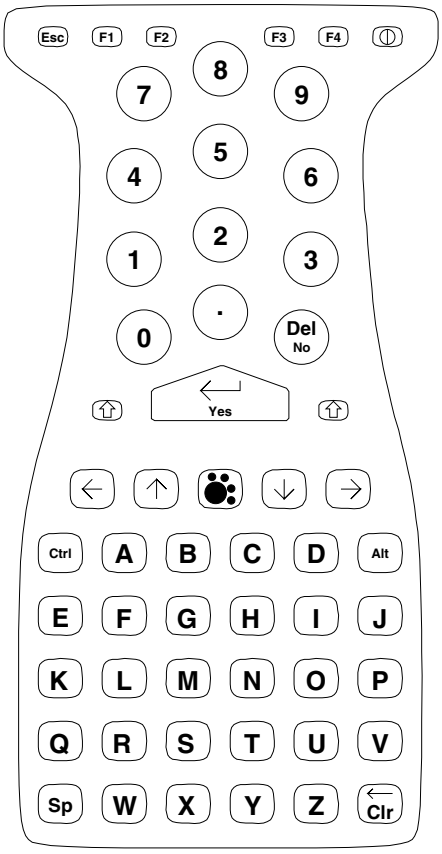
The keyboard is initially in mode 1 (developer mode), but you can switch between the two modes at any time by holding down both ⇧ keys and pressing the key immediately above ↵ (usually ⊙).

The Ctrl and Alt keys are used as on a normal PC compatible keyboard. The PAW key (☼) provides special control functions for the display, backlight, sound and other facilities. An application will normally lock the keyboard into mode 2 (user mode); if users require access to these functions, the application can provide this via extended BIOS calls described in Part 3.

Note: This manual generally assumes that the keyboard is in mode 1 unless stated otherwise.

7.4.2 Normal keys (default keyboard mode)

The default keyboard looks like this:

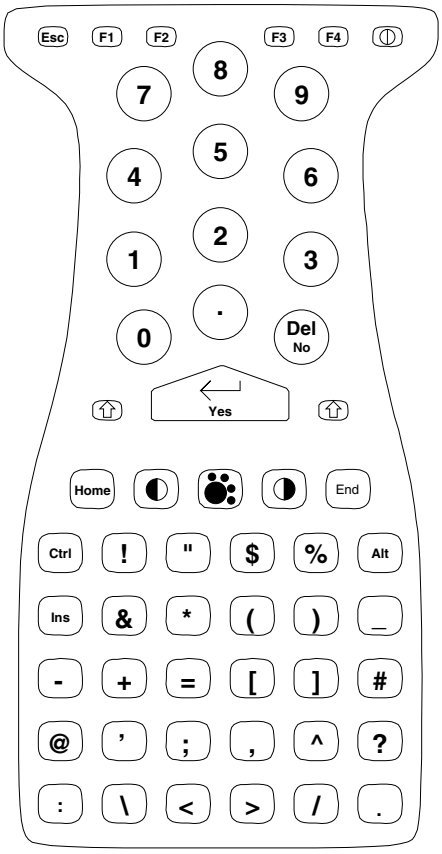


Note that the letter keys type small letters. To type capitals, select CAPS LOCK mode (press ❀ Ⓒ).

7.4.3 Shifted keys (default keyboard mode)

When used with either of the ⇧ (Shift) keys, the main keys function as follows:

Note that the numeric keypad is normally unaffected by Shift.



7.4.4 Special keys

Certain other keys must be typed as key combinations, using the special 🐾 key:

For:	Type:
F5 ...F10	🐾 plus the function key number. Use 0 for F10.
Scroll Lock	🐾 Esc
Ctrl Break	Ctrl 🐾 Esc
keypad *	🐾 P
Prtsc	Shift 🐾 P
CapsLock	🐾 C

The 🐾 key is also used to provide a number of control functions, as described in the next section.

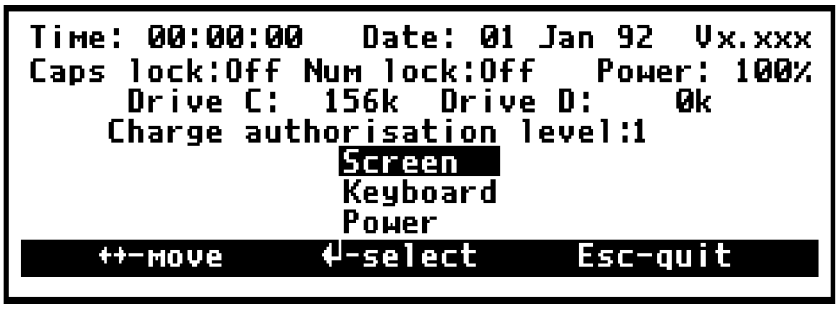
The 🐾 key also provides access to a number of control functions, as follows:

To:	Press:
Shift window left	🐾 ←
Shift window right	🐾 →
Shift window up	🐾 ↑
Shift window down	🐾 ↓
Flip window	🐾 F
Increase contrast	🐾 E
Decrease contrast	🐾 X
Display LCD map	🐾 M
Turn backlight on/off	🐾 L
Adjust sound level	🐾 S
HOT key	🐾 H

The screen control keys have already been described in section 7.3.

Use the sound level key to adjust the volume of all sounds issued by the **FS/2**. Each time you press it, the volume changes: from off, to low volume, to high volume, to off again.

The HOT (or status) key is used to display and optionally alter aspects of the **FS/2 set-up. When you press this key combination, the** screen displays the following information:



- The time and date.
- The state of the CAPS LOCK function.
- If Advanced Power Management (APM) is enabled, the percentage power remaining and charge authorisation level. (This dictates whether you can recharge the internal batteries by using the **Husky** AC adaptor. For details, see section 8.2.2.)
- The free space remaining on drive C (RAM disk) and drive D (FLASH EPROM) if fitted).

To return to the normal screen display, press Esc or press ❀ H again.

This key also allows you to adjust the screen, keyboard and power settings. For full details, see Chapter 11.

7.5 Using MS-DOS

The **FS/2** operating system is the industry-standard for desktop computers, Microsoft's MS-DOS. The version used is 3.3.

If you are not already familiar with using MS-DOS, you should consult the *MS-DOS User's Reference* for an introduction to details of the standard facilities and commands.

The following standard MS-DOS commands will always be available, whatever directory you are in (as they are built into COMMAND.COM):

BREAK	Turn detection of Ctrl Break on or off
CD (CHDIR)	Change directory
CLS	Clear screen
COPY	Copy file(s)
DATE	Set/display date
DEL (ERASE)	Delete files
DIR	Display directory/file details
MD (MKDIR)	Create directory
PATH	Define search path for commands
PROMPT	Redefine system prompt
REN (RENAME)	Rename files
RD (RMDIR)	Delete directory
SET	Set environment variables
TIME	Set/display time
TYPE	Display contents of text file
VER	Display MS-DOS version number
VERIFY	Turn verification of disk writes on or off
VOL	Display disk label

The GWBASIC BASIC interpreter is also supplied, together with the following MS-DOS utilities, which are in the C:\DOS directory:

ANSI.SYS	FIND.EXE	MORE.COM
APPEND.EXE	FORMAT.COM	PRINT.COM
ASSIGN.COM	GRAPHICS.COM	REPLACE.EXE
ATTRIB.EXE	GWBASIC.EXE	RESTORE.COM
BACKUP.COM	JOIN.EXE	SORT.EXE
CHKDSK.COM	KEYB.COM	SUBST.EXE
COUNTRY.SYS	KEYBOARD.SYS	SYS.COM
DEBUG.COM	LABEL.COM	TREE.COM
FASTOPEN.EXE	MODE.COM	XCOPY.EXE
FC.EXE		

For details of GWBASIC, see the *GWBASIC User's Guide*. For details of the MS-DOS utilities, see the *MS-DOS User's Reference.*

These are supplied as (read-only) files in the C:\DOS directory. If you find you can't use these utilities, add this directory to your search path. (For details of search paths, see PATH in the *MS-DOS User's Reference*.)

The following special utilities are also provided as (read-only) files in the C:\ directory:

COM	Simple file transfer utility
HCOM	Versatile file transfer utility
UTIL	Format drive C
	Set time/date
	Configure communications
	Configure memory
XL	File loader utility with XMODEM protocol built in

Again, if you want to use these utilities, you may need to add their directory (C:\) to your DOS search path.

The Husky communications utility, HCOM, is supplied on an MS-DOS disk for use on a desktop PC. EDIT, a simple text editor, is also available for the **FS/2**; it is provided on diskette and must be loaded onto the **FS/2** before it can be used.

There is also a status/set up function, accessed via a HOT key.

HCOM, COM, XL, EDIT, UTIL and the HOT key are all described in more detail later in this guide. For information on:

- HCOM, see section 14.6.
- COM, see section 14.5.
- XL, see section 14.7.
- EDIT, see Chapter 12.
- UTIL, see Chapter 10.
- The HOT key, see Chapter 11.

Other commands, utilities and applications may also have been installed for you to use, by your technical support team. If you are meant to use them, instructions should also be supplied.

7.6 EMC legislation

To ensure compliance with EMC legislation:

- Use only the approved **Husky FS/2 AC Adaptor**.
- All communications cables must be shielded. Use Husky approved cables.
- The maximum system configuration may be limited by local EMC regulations. Consult your system supplier for advice.
- The **FS/2** must only be used with approved peripherals.
- Changes or modifications could void the user's authority to operate the equipment.

Chapter 8 Regular Maintenance

Once you have issued a unit to an operator, you will probably see it at regular intervals eg to charge the batteries, load revised applications or data, or retrieve data from the unit (see Chapter 14). This will give you the opportunity to carry out quick checks and maintenance steps on a regular basis.

This chapter summarises the main steps that you should take to make sure that the **FS/2** continues to provide trouble-free operation. The next chapter describes what to do if problems do arise!

8.1 Routine maintenance and checks

The **FS/2** needs very little routine maintenance:

- Check the internal humidity indicator, which is visible through a small hole in the bottom right corner of the display window. If this takes on a pinkish colour, remove the internal batteries and return the unit at once to Husky Computers (or their local agents) to avoid corrosion of internal parts.
- Replace or recharge batteries at regular intervals, as described in section 8.2.
- Clean the display screen and case with a clean cloth.
- If the unit is very dirty, clean it as follows:
    - Make sure that the battery cap is tight. If it has been dropped, check that the case and seals are intact.
    - Gently rinse the unit under clean running water (no more than hand hot, 40˚C, 105˚F). Do not immerse the unit unnecessarily, or use a high pressure jet.
    - To remove stubborn deposits, use a soft bristle brush and a mild detergent or soap. TREAT THE KEYBOARD GENTLY.

CAUTION: **Do not use organic solvents or harsh detergents, as they may damage the casing. To remove stubborn deposits, you can use a solvent such as Dimethylcarbinol or Methylated Spirits (denatured alcohol), but use them carefully as they can remove paint or leave marks.**

- Blow any water out of the connectors, then leave it to drain and air dry, or use a hair dryer on a low temperature setting (less than 55˚C, 130˚F). DO NOT EXPOSE THE UNIT TO TEMPERATURES ABOVE 55˚C (130˚F).
- Finally, polish the screen with a clean cloth.

- The battery cap relies on an 'O' ring for case sealing. Make sure that the cap is kept tight.
- If fitted, check any straps for signs of wear and replace them if failure is likely, to minimise the risk of the **FS/2** being dropped in use.

8.2 Power

CAUTION: **If you change from rechargeable to non-rechargeable batteries, warn anyone you give the unit to. Non-rechargeable batteries must NOT be recharged. Always use batteries of the same type and charge state - don't mix fresh batteries with used batteries, or rechargeable batteries with non-rechargeable ones. Observe the instructions printed on the battery. Replace only with batteries approved by your FS/2 supplier. DO NOT FIT LITHIUM BATTERIES.**

ATTENTION: **Dispose of or recycle used batteries according to the manufacturer's instructions. Nickel-Cadmium rechargeable batteries must be recycled, or disposed of properly.**

CAUTION: **BATTERY CHEMICAL LEAKAGE IS CORROSIVE. In the unlikely event of battery leakage, do not touch. In case of accidental contact, flush immediately with running water.**

8.2.1 Introduction

The **FS/2** can be operated from different power sources:

1 Rechargeable A-size NiCad batteries

2 Alkaline batteries

3 The **FS/2 AC Adaptor**

4 The **FS/2 Communications and Charging Rack** (the **Rack**)

This ability to switch between these power sources provides unrivalled convenience for users. For example, you can power the **FS/2** from the AC adaptor while in the office and fit it with rechargeable batteries for use while on the move. If a user forgets (or is unable) to recharge the batteries while away from the office, they can substitute easily obtainable alkaline batteries if required.

While NiCads can be recharged using the AC adaptor, alkaline batteries must not. To minimise the risk of attempting to recharge alkaline batteries, the **FS/2** can be set up to disable charging, or to enable charging but ask the user if charging is still allowed the next time it is turned on after changing batteries.

To increase battery life, special low power components and an automatic power-saving system are used. Power monitoring and warning systems are provided to keep you informed.

To protect the contents of the memory and disk, a trickle-charged internal battery is fitted, which provides sufficient backup power to preserve their contents for at least 7 days at 20˚C (68˚F), if the main power source is removed.

Note: For detailed background information on the power management system, see section 8.2.5. For more technical information, including typical power usage figures, see the chapter on using power handling, in Part 3.

8.2.2 Using rechargeable batteries

THESE INSTRUCTIONS RELATE TO PERSONNEL SAFETY AS WELL AS RELIABLE OPERATION OF THE FS/2 AND AC ADAPTOR. IT IS IMPORTANT THAT THEY ARE READ AND UNDERSTOOD.

CAUTION: ALSO REFER TO THE PRECAUTIONS AT THE FRONT OF THIS MANUAL AND ANY OTHER DOCUMENTATION SUPPLIED WITH THE AC ADAPTOR BEFORE USING IT.

The **FS/2** can be fitted with three standard A-size NiCad rechargeable batteries. We strongly recommend that you use the **FS/2 Battery Stick** or Husky-approved NiCads only.

The batteries can be recharged by connecting the supplied AC adaptor or by using the **FS/2 Communications and Charging Rack**. Note that charging is normally disabled when operating at extremes of temperature (outside 5˚C to 40˚C, 41˚F to 104˚F).

Recharging takes significantly longer at higher temperatures.

8.2.2.1 When to recharge

Rechargeable batteries provide between 10 and 16 hours operation (depending on use) when fully charged, so you should normally recharge them before each working day (eg overnight) to maintain maximum operating time. You should also recharge the batteries if:

- The following message is displayed every few seconds when you turn on:

  ```
  WARNING BATTERIES ARE LOW
  ```

- A message is displayed by the application telling you that power is low.
- The **FS/2** will not power up.
- You know that the batteries won't last the next working day (if using APM, you can check the battery level by using the HOT key (Ⓕ Ⓗ).
- The batteries haven't been recharged for several weeks. NiCads self-discharge, especially at elevated temperatures, so even if the **FS/2** has simply been stored without being used, it may need recharging after two to three weeks.

If you need to use the **FS/2** immediately, you can change the batteries or use the **FS/2 AC Adaptor**. If you change to non-rechargeable batteries, you MUST remove charger authorisation or disable charging; refer to section 8.2.2.5 for details.

8.2.2.2 Recharging batteries

You can recharge the batteries in four main ways:

- By removing them and placing them in a separate charger. This will not be described further here. (If you are using APM charge them fully, and when you fit the batteries again, set the power level to 100%.)
- By connecting the **FS/2 AC Adaptor**, with charging enabled.
- By placing the **FS/2** on the **FS/2 Communications and Charging Rack**, with charging enabled.
- By connecting to a 12V vehicle battery via the Husky in-vehicle charging cable, with charging enabled. Contact Husky or your supplier for details.

The special **FS/2 AC Adaptor** is the only AC adaptor which may be used to recharge the NiCad batteries when they are installed in the **FS/2**. Using a non-approved AC adaptor or battery eliminator may damage the **FS/2** or the batteries.

If Standard Power Management (SPM) is selected, charging is enabled by default. This means that you can simply leave the unit to recharge and don't need to do anything else. (However, the application may disable charging. If in doubt, check the application's user instructions.)

If Advanced Power Management (APM) is selected, charging must be enabled and charging authorisation must be granted before batteries will recharge. You may be able to change these by using the HOT key **`Power`** option, or application options. If you do not know, ask the person who wrote the application.

CAUTIONS

When using the AC adaptor be absolutely certain that the FS/2 has three NiCad cells correctly aligned and no other type is present. Do not even mix NiCads of different age or state of charge, as this produces a risk of chemical leakage, gassing or explosion. Do not attempt charging at temperatures outside the range 5˚C to 40˚C (40˚F to 104˚F).

The AC adaptor contains lethal voltages, so under no circumstances should it be opened, in any way tampered with, or used for any other purpose. Keep it dry. There are no user serviceable items inside the case.

The AC adaptor is fully protected against continuous short circuits and is double insulated, so an earth connection is not necessary.

During charging, the FS/2 may heat up noticeably, particularly if powering peripherals while charging, but this does not pose a hazard unless using charging voltages significantly higher than the nominal +7 to +12V DC supplied by the FS/2 AC adaptor. Contact Husky Computers for further information.

Procedure

To recharge using the AC adaptor the following procedure is recommended:

1 Switch off the **FS/2**.

2 Plug the AC adaptor into the **FS/2** 5-way connector. Push the plug in until the outer sleeve is flush with the casing.

3 Plug the AC adaptor into the AC outlet.

4 Switch on the AC outlet.

5 Charging should begin. Wait for the batteries to charge fully. If APM is enabled you can check the power level by turning on and using the HOT key (Ⓘ Ⓗ).

Note: Do NOT adjust the **`Power remaining`** manually, as this will interfere with the automatic control of charging and power monitoring.

If convenient, you may leave the batteries to charge overnight. You may also disconnect the AC adaptor before the batteries are fully charged if you need to.

6 When charging is finished, turn off or disconnect at the AC outlet, then disconnect the AC adaptor from the **FS/2**.

You may turn on and use the **FS/2** even during charging.

As with all electrical apparatus, the AC adaptor should be disconnected from the AC outlet when not in use. Only 240V AC (220 to 250V), 50 or 60 Hz is suitable for standard units. AC adaptors for alternative supplies, such as 110V, are available.

If batteries will not recharge

If batteries will not recharge, the most likely reason is that charging has not been enabled as described in section 8.2.3.3.

If using SPM, your application may have disabled charging. Read your application's user instructions to see how to enable charging.

If using APM, the application or the charging authorisation level may have turned off charging. For example, if level 2 is selected the **FS/2** will disable charging when it is next turned off. To check, use the HOT key ie press Ⓘ Ⓗ and select the **`Power`** option and press ⏎:

- If **Battery chargeable** is set to **No** press → to move to it and press ↑ to change it to **Yes**
- If **Charging authorisation** is set to **Level 1**, move to it and use ↑ to enable charging by selecting one of the following levels:

  2 to allow charging until turned off (eg by using ⏻ or changing the batteries).

  3 to allow charging until the batteries are changed (or all power is lost), then ask the user if charging should still be allowed.

  4 to always allow charging.

  If you select a level other than 3, the HOT key power menu will be displayed the next time the user turns on after removing and fitting the battery cap.

  When you have finished, press ↵ and then Esc to leave the HOT key.

If the HOT key does not work or the **Power** option is not displayed, the application may provide similar facilities. If you are not sure, refer to the application's user instructions.

If the HOT key shows that the batteries are chargeable, but they still will not recharge, they may need replacing. See section 8.2.2.4 for details.

Note: Even if the main batteries are removed or completely discharged, the contents of the RAM disk will still be preserved by another independent battery which is fitted internally. This should protect the contents of the memory and disk for at least seven days, but does not allow operation. If the **FS/2** may be without power for more than a few days, copy any files that you want to keep onto another system (eg a PC's hard disk) first, for added security.

8.2.2.3 Caring for rechargeable batteries

In normal use, rechargeable batteries will last at least two years before they need to be replaced, although their life is reduced by repeated or prolonged total discharge and by excessively high temperatures. During this period,

their capacity should only decrease slightly. However, batteries may also exhibit a "memory effect" which reduces their capacity (temporarily) if they are repeatedly recharged when only partly discharged.

Therefore, to maintain battery capacity, follow these simple rules:

- Don't recharge the batteries when they have a significant charge remaining.
- Don't leave recharging until the batteries are completely exhausted.
- Don't store the batteries (or **FS/2**) at high temperatures.

If battery capacity drops prematurely, it may be caused by the memory effect. Try putting the batteries through several full charge/discharge cycles, as follows:

- If the application provides a deep discharge option, use that.
- If the application does not provide a fast discharge or deep discharge option, run the **FS/2** until it displays battery low warnings and then charge it fully.

Repeat the discharge/recharge cycle two or three more times. If this does not restore the battery capacity, you should replace them as described in the next section. Note that cycling may also improve the performance of old batteries, but this is purely temporary, so the batteries should be replaced.

If the **FS/2** turns itself off without battery low warnings in APM mode, the most likely reason is that the "power remaining" value is too high. The simplest way to correct this is to leave the unit on charge for at least 12 hours. When the power remaining reaches 100%, the charging current will be reduced to trickle charging, which should be sufficient to "top up" the batteries.

Another possibility is that the "low power warning onset" is set too low. Use the HOT key (or application option) to display the Power Parameters menu and check that the **`Low power warning onset`** is set to at least 5%.

8.2.2.4 Replacing rechargeable batteries

With typical usage patterns, you will need to replace the NiCads every 12 to 18 months, to maintain a reasonable capacity. To replace the batteries, follow the instructions in section 8.2.3.2, then charge them fully as described in section 8.2.2.2 set the power remaining to 0% before you begin charging unless you are sure of the batteries' charge.

Note: Several discharge/charge cycles may be required before NiCad cells reach their peak capacity.

8.2.2.5 Changing to non-rechargeable batteries

To change over to Alkaline batteries if you are using SPM:

1 Turn off, remove the rechargeable batteries and fit the Alkaline batteries in their place, as described in section 8.2.3.2.

2 Turn on. This should return you to your application. Select the option which selects Alkaline batteries or disables charging (see the application's user instructions).

If you are using APM:

1 Turn off, remove the rechargeable batteries and fit the Alkaline batteries in their place, as described in section 8.2.3.2.

2 Turn on.

3 If the charging authorisation is level 3, the following message will be displayed:

```
Level 3 - Continue charging : No
```

If **No** is not displayed, press ↑ to display it, then press ↵ and the Power Parameters will be displayed. Continue from step 5.

4 If the charging authorisation level is 1, 2 or 4, the Power Parameters menu should be displayed already. If not:

- Press 🐾 H
- Select the **Power** option
- Press ↵ to continue with APM

5 Now, disable charging and set the battery capacity and power level:

- Set the **`Charging authorisation`** to 1 to disable charging. This is essential for safety reasons.
- Set the **`Battery capacity`**. (Typical alkalines have a usable capacity of about 1800mAh. The nominal capacity quoted by manufacturers is rather optimistic; the usable capacity is typically about 80% of this.)
- Set the **`Power remaining`**. (Typically to 100%, if the batteries are fresh.)
- Press ↵ and then Esc to leave the menu.

If you cannot display the Power Parameters menu, the application may provide similar facilities in a more convenient form. If you are not sure, refer to the application's user instructions.

CAUTION: NEVER connect the AC adaptor with alkaline batteries installed! They will NOT re-charge. Instead, they may explode, jam in the battery tube or leak corrosive chemicals.

8.2.3 Using non-rechargeable batteries

THESE INSTRUCTIONS RELATE TO PERSONNEL SAFETY AS WELL AS RELIABLE OPERATION OF THE FS/2 AND AC ADAPTOR. IT IS IMPORTANT THAT THEY ARE READ AND UNDERSTOOD.

We strongly recommend the use of Alkaline-Manganese batteries, such as Duracell or Mallory MN1500s. You will need three AA-size batteries to operate the **FS/2**. (A-size Alkaline Manganese batteries are not readily available.)

CAUTION: Do not mix batteries of different types, sizes, or states of charge. Do not fit Lithium batteries under any circumstances.

We do not recommend use of the cheaper Zinc-Carbon batteries for routine operation, as they may leak (damaging the **FS/2**), have shorter lives, and may cause technical problems. You may however use such batteries for short periods, in an emergency.

Alkaline cells should provide up to 30 hours of operation when running a typical application, and a shelf life of several years. There is no need to remove them during shipment or storage, but remember that their capacity will decrease slowly with time.

Usable battery capacity is significantly reduced by operating at low temperatures or with additional loads (such as the internal modem or powering external peripherals).

8.2.3.1 When to change non-rechargeable batteries

Alkaline batteries should provide approximately 30 hours operation (depending on use), so if a unit is being used frequently, you might need to replace its batteries each week. You should also change the batteries if:

- The following message is displayed every few seconds when you turn on:

  ```
  WARNING BATTERY LEVEL LOW
  ```

- A similar message is displayed by the application saying that power is low.
- The **FS/2** will not power up.
- You know that the batteries are nearly exhausted and will be relying on the batteries for an extended period.

To avoid problems, issue users with a spare set of batteries.

Note: If the main batteries are removed or completely discharged, the contents of the RAM disk will still be preserved by another independent internal battery, for at least 7 days at 20˚C (68˚F). This battery does not allow operation. If the **FS/2** may be without power for more than a few days, copy any files that you want to keep to another system (eg a desktop PC's hard disk) first, for added security.

8.2.3.2 How to change non-rechargeable batteries

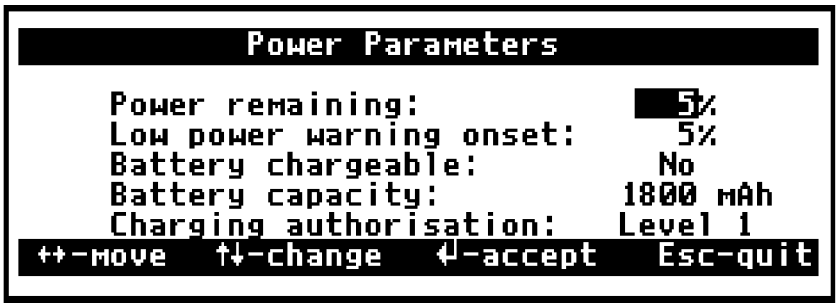
CAUTION: Do not mix batteries. Replace all 3 at the same time, with batteries of the same type.

To change the batteries:

- Turn off.
- Use a COIN to unscrew the battery cap. (A screwdriver may damage the slot and the **FS/2** appearance.)
- Remove the old batteries and dispose of them safely.
- Feed in the cells carefully, **positive inwards**. If you are fitting AA-size batteries, insert them in the battery packing tube (supplied with **FS/2**) first.
- Take the battery cap and, with finger pressure only, press it into the battery compartment and turn it clockwise.
- Only when the thread is started, use a coin to screw the cap tightly home.
- Turn on and you should be able to carry on from where you left off using the **FS/2** (assuming SPM).

OR

- If Advanced Power Management is enabled, when you turn on the **FS/2** will display:



- Set **`Power remaining`** to 100% by using the cursor keys, then press ↵ to carry on using the **FS/2**.

- If Advanced Power Management is enabled but you do not see this screen, the application may provide a similar facility, with a name such as 'New battery'. (If in doubt, check the application's user instructions.)

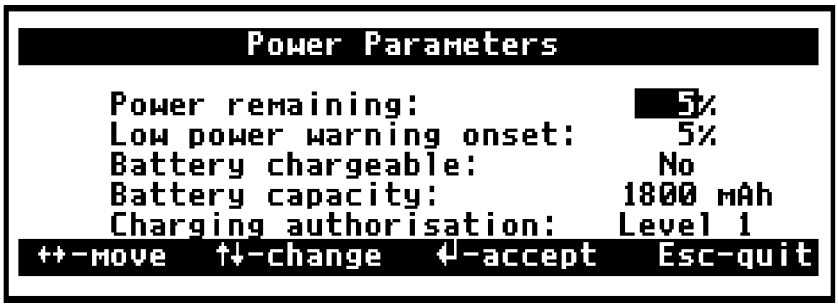
8.2.3.3 Changing to rechargeable batteries

The **FS/2** can be operated from three standard A-size NiCad batteries. We recommend that you use the **FS/2 Battery Stick** or Husky-approved NiCads.

Changing over to NiCad batteries is easier if they have some charge, so charge them if you can, for example by using a battery charger. New NiCads are usually not charged.

If the NiCads have some charge:

- Turn off the **FS/2**.
- Remove the Alkaline batteries and fit the NiCads in their place, as described in section 8.2.3.2.
- Turn on.
- **If the FS/2 is using SPM**, you should be able to carry on from where you left off.
    - If the NiCads are not fully charged, enable charging (see the application's documentation) and charge them as described in section 8.2.2.2. Charging is faster while turned off.
    - Before you give the **FS/2** to the user, remember to enable or disable charging, as appropriate for this user.
- **If the FS/2 is using APM**, when you turn on it should display:



- The highlight should be next to the **`Power remaining`** prompt. If not, use ⇦ or ⇨ to move to it. Use ⇧ or ⇩ to adjust the **`Power remaining`** to the power in the batteries. If you are not sure, select a low figure and make sure that the batteries are charged for at least 12 hours, which should correct for any inaccuracy.
- Press ⇨ twice to move to the **`Battery chargeable`** option, then press ⇧ to set it to **`Yes`**.
- Press ⇨ again to move to the **`Battery capacity`** option, then use ⇧ and ⇩ to set the capacity. Typical A-size NiCads have a capacity of 1000 to 1400mAh. If the manufacturer quotes a nominal capacity, use 80% of this (or less, if heavy loads are expected).
- Press ⇨ again to move to the **`Charging authorisation`** option, then use ⇧ to set the level as follows:

  1 means do not allow charging.

  2 means allow charging only until powered down (for whatever reason).

  3 means allow charging until the battery cap is removed (or all power is lost), then ask if charging is still allowed.

  4 means allow charging permanently. Use this option with caution.

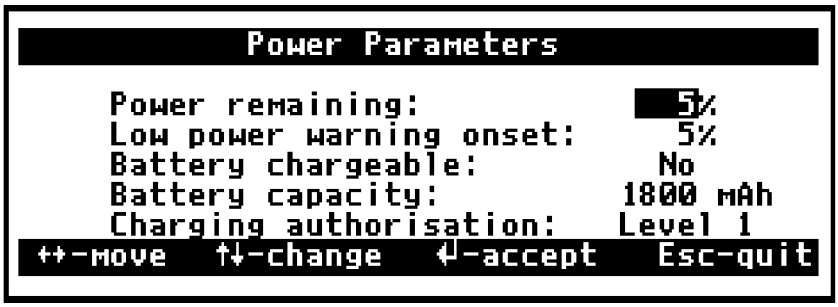
(If you are not sure which option you want, select option 3 to enable charging for now.)

- When everything is set correctly, press ⏎ to carry on using the **FS/2**. If the batteries are not fully charged, charge them as described in section 8.2.2.2. Charging is faster with **FS/2** turned off.
- Remember to set the charging authorisation correctly once finished. For example, if the user is not meant to charge the batteries, set it to level 1.

If Advanced Power Management is enabled but you do not see the above screen, the application may provide a similar facility, with a name such as 'Changing to NiCads'. (Check the application's documentation.)

If the NiCads have NO charge:

- Turn off the **FS/2**.
- Fit the NiCads as described in section 8.2.3.2.
- Connect the AC adaptor (see section 8.2.4). This will slowly trickle charge the batteries.
- Wait for at least one hour, then turn on.
- **If the FS/2 is using SPM**, you should be able to carry on from where you left off:
  - Leave the batteries to charge fully. Charging is faster with **FS/2** turned off.
  - Before giving the unit to the user, remember to disable charging, if appropriate for this user.
- **If the FS/2 is using APM**, when you turn on it should display:



- Set the power options as described above (see **If the NiCads have some charge**). Set **`Power remaining`** to 5%.
- Leave the batteries to charge fully. Charging is faster with **FS/2** turned off.
- Remember to set the charging authorisation correctly once finished. Level 4 is not appropriate for most users. For example, select level 3 to allow charging but prompt the user if he or she removes the battery cap (in case they have changed over to non-rechargeable batteries).

8.2.4 Using the AC adaptor

CAUTION: **NEVER connect the AC adaptor when alkaline batteries are installed; they may explode, jam in the battery tube or leak corrosive chemicals.**

Note: The AC adaptor is intended for use only with NiCad rechargeable batteries fitted to the **FS/2**. Operating the **FS/2** direct from the AC adaptor without batteries fitted is not normally recommended; please contact your supplier or Husky Technical Support if you require further information.

To use the **FS/2 AC adaptor**:

1 Make sure that charging is enabled. If using APM mode, set **`Charging authorisation`** to 3 or 4 and **`Power remaining`** to less than 100%; if alkaline batteries are fitted, you must select level 4 and remove the batteries in step 2.

2 Switch off the **FS/2**. If alkaline batteries are fitted, remove them and fit NiCads; see section 8.2.3.3.

3 Plug the AC adaptor into the **FS/2** 5-way connector. Push the plug in until the outer sleeve is flush with the casing.

4 Plug the AC adaptor into an AC outlet and switch on the AC outlet.

5 You can now turn on and use the **FS/2** as normal, except that it will not power any peripherals. If APM is enabled, the battery level displayed will be at least 6%.

CAUTION: If you are going to leave the FS/2 powered by the AC adaptor for a long time (days rather than hours), we recommend that you disable charging once the NiCads are fully charged.

To disconnect the mains adaptor:

1 Turn the **FS/2** off.

2 Turn the AC outlet off and unplug the adaptor from the outlet.

3 Unplug the adaptor from the **FS/2**.

8.2.5 The power management system

This section provides background information on the **FS/2 power management system.**

8.2.5.1 Data protection

As already mentioned, an internal rechargeable battery is fitted, which is trickle charged from the main power source (eg batteries) and used to protect the contents of the RAM disk. This charging may take up to approximately 28 days if the backup battery is totally flat and the **FS/2** is turned off. (If you need to charge the backup battery faster than this, ask your supplier for the FLASHBAK utility and instructions.)

The backup battery should not need replacing.

8.2.5.2 Power monitoring

The **FS/2** provides two alternative power monitoring modes, which may be selected by using the HOT key or by the application.

If **Advanced Power Management** (APM) is enabled, the **FS/2** monitors power usage continuously so the power level can be read by an application (or displayed by pressing the HOT key if using the default keyboard). To correct for NiCad batteries' high self-discharge rate, the power level is also decreased by 3% each day that the **FS/2** is not used. The level is displayed as a percentage of total battery capacity. Access to charging depends on the charging authorisation level. For example, if level 3 is selected and you change batteries, the **FS/2** will ask whether charging is still allowed when next turned on.

If Advanced Power Management is disabled, the **FS/2** is in **Standard Power Management** (SPM) so you can no longer check the battery level, but other aspects of power conservation and low power handling are similar.

8.2.5.3 Low Battery Warning

The **FS/2** is designed to provide adequate warning of impending battery failure and will protect user's data, even in the worst situations.

If Advanced Power Management (APM) is enabled, you can set the battery level at which warnings are given (normally, 5% charge) by using the HOT key. If Standard Power Management (SPM) is enabled, warnings are given when the battery voltage is getting low.

The low power warning message is displayed on the top line of the screen and looks like this:

```
WARNING BATTERY LEVEL LOW
```

The **FS/2** bleeps to draw attention to the warning, then restores the original display until the next warning.

Since it is usually essential that all data and programs are preserved, the user should switch off as soon as practical and either replace the batteries with a fresh set or, if rechargeable batteries are fitted, put them on charge.

If the user does not turn off, the warnings will be repeated every 5 seconds. After ten consecutive warnings, the **FS/2** will switch off automatically (unless overridden by your application).

When power is restored, program execution will continue from precisely where it was prior to the interruption.

If the user tries to use the **FS/2** without replacing or recharging the batteries or connecting an AC adaptor, another warning message will be displayed and it will immediately turn off again.

In either mode, if the battery level falls so low as to endanger the memory contents, the **FS/2** hardware will turn off to preserve the memory, without displaying a warning message.

Note that flat batteries can recover partially after being switched off, allowing operation for a short period. This is not good practice, particularly with rechargeable batteries, as these could become totally exhausted.

8.2.5.4 Idle Timeout

If the **FS/2** is left turned on and not used, to conserve power it will emit a warning bleep and switch off automatically if the keyboard is not touched for 5 minutes (this period may be changed by using the HOT key (see section 11.4.2) or by an application program: see Part 3). When the user turns on again, execution will continue normally.

8.2.5.5 Power Save

An automatic power conservation system is incorporated which monitors operation and removes power from circuits when they are not in use. The **FS/2** will enter power save mode automatically whenever it is waiting for keyboard input or serial input; this has no effect on operation other than prolonging battery life.

8.2.5.6 Controlling charging

The **FS/2** can be used with Alkaline (non-rechargeable) or NiCad (rechargeable) batteries. NiCads can be charged by fitting the AC adaptor, but Alkalines must not, as they may explode, jam in the battery tube, or leak corrosive chemicals.

If Advanced Power Management is enabled the **FS/2** uses a ‘charging authorisation’ mechanism to help prevent problems. By default, the authorisation level is set to 1, meaning that the AC adaptor will not charge the batteries.

While this is quite safe, it means a user must remove the NiCads to recharge them, which may be inconvenient. To allow charging from the AC adaptor, the user must change the authorisation and then enable charging, by either using the HOT key power option, or the application. The application must provide the user with access to one (or both) of these facilities if they are supplied with an AC adaptor and expected to recharge their own batteries.

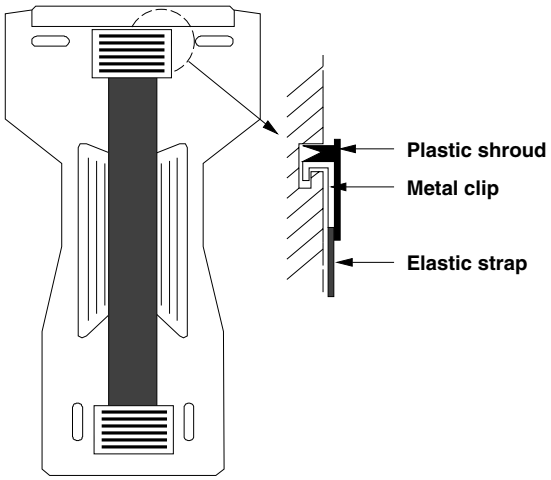
If Advanced Power Management is disabled, charging may be enabled or disabled (by the application). The application may also provide a fast charge option.

If an AC adaptor is connected to an **FS/2** with flat batteries, it will deliver a very low trickle current to them, charging NiCads enough to turn on within one or two hours.

8.3 The handstrap

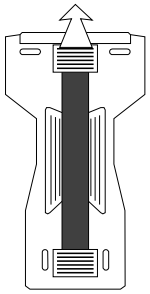
The **FS/2** is normally fitted with a hand strap, which fastens to the back of the unit.

It is held in place by two metal hooks at each end of the strap, that fit into circular recesses at the back of the unit, and plastic shrouds that also clip into the recesses. The tension in the elastic strap also helps hold the hooks in place.

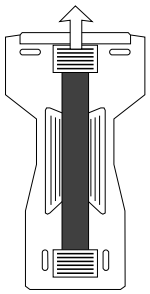


To remove the hand strap:

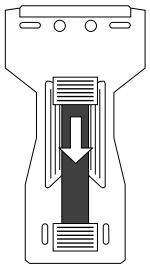
- Turn the **FS/2** over and grip the plastic shroud at one end. Pull it up to unclip it from the recesses.



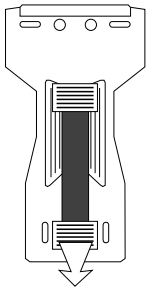
- Now, stretch the strap and the hooks should slide backwards so you can lift them out of the recesses.



- Release that end of the strap. Lift the shroud from the other end to unclip it and the hooks should slide from their recesses.



- You should now be able to remove the strap from the **FS/2**.



To fit a new handstrap, familiarise yourself with the main diagram above, then:

- Turn the **FS/2** over.
- Fit the hooks at one end of the strap into one set of recesses. Press the shroud into the recesses.
- Grip the shroud at the other end of the strap and stretch it to reach the other set of recesses.
- Insert the hooks and let go. The strap should snap into place. Press the shroud into the recesses and the job is complete.
- Check that the hooks are properly seated (the shroud is flush with the **FS/2** case) and that the strap is firm.

8.4 The keyboard overlay

The **FS/2** is normally shipped with a self-adhesive keyboard overlay fitted, which may be customer-specified or one of the standard layouts. Overlays can be removed and replaced.

To remove an overlay:

- Insert a fingernail under one corner of the overlay and pull it gently away from the keyboard.
- Peel the overlay off.

To fit an overlay:

- Remove any existing overlay and clean the keyboard area if necessary. Make sure that it is quite dry.
- Peel off the backing paper.
- Gently lower the overlay over the keys, making sure that the edges of the keys do not foul it, particularly as they are depressed. (The keys are hinged at the front.)
- When you are sure that the overlay is correctly positioned, press it firmly into place.

8.5 Storage

If storing the **FS/2**, observe the storage conditions described in Appendix B.

If you wish the **FS/2** to retain the data stored on its internal disk, store it with batteries fitted and check these at regular intervals (typically once a month), for charge and any signs of leakage. If the batteries are deteriorating, replace or recharge them at once.

For extended storage, we recommend you fit alkaline batteries.

8.6 Extending, repairs and internal upgrades

If anything should go wrong with the **FS/2**, it is covered by a warranty. For the terms and details of this warranty, contact your supplier.

Repairs should only be performed by your Authorised Service Agent or Husky Computers. In the first instance, contact the distributor.

You should also contact Husky Computers or your local distributor if you want to extend the **FS/2** facilities by adding extra internal options.

Chapter 9 Troubleshooting

The **FS/2** is designed, built, and tested for robustness, including robustness of program execution.

However, as with any complex system, things may go wrong, particularly while users are unfamiliar with its operation.

This chapter provides a simple introduction to diagnosing and solving problems which may arise in the field. Detailed information on problems which may arise while using the facilities described in this manual are provided in the chapters describing how to use them. For information on troubleshooting operation from MS-DOS, see the *MS-DOS Programmer's Manual*.

9.1 Common Problems

There are some specific situations that can cause the **FS/2** to mis-execute an application. The commonest causes are as follows.

9.1.1 Programming errors

Applications may include bugs that would crash any computer. Programmers are of course responsible for the logical correctness of their programs.

Applications may make invalid system calls, with unpredictable results. Programmers must remain within the programming guidelines included in this guide and the *MS-DOS Programmer's Manual* if they wish their programs to behave correctly.

9.1.2 Physical abuse

Excessive physical abuse may damage the unit. In most such instances, the physical cause will be obvious. Contact your supplier for repairs.

If the humidity indicator changes colour immediately after an accident involving water or high humidity, the sealing is faulty and there could be water inside the unit. If you suspect that water has entered the interior, you MUST remove the batteries to minimise the risk of corrosion.

9.1.3 Operation outside specified temperature range

The **FS/2** is specified for operation in the range -30˚C to +60˚C (-22˚F to +140˚F). Operation at low temperatures restricts battery capacity and slows LCD screen response time.

9.1.4 Keyboard operation

If the keys seem stiff, they may be fouling the keyboard overlay. This is particularly likely at the top edge of the keys. Try removing and refitting the overlay. If you cannot refit it, you need to fit a new overlay. If the overlay is not the problem, check to see if the keyboard area is contaminated. If it is, the unit should be returned for servicing, but you may be able to improve operation in the mean time as follows.

If the keyboard is contaminated with a dry powder or dust, you may be able to remove it by using a high pressure air-line.

If the keyboard is contaminated with a wet or sticky substance such as coffee or grease, clean it carefully as described in section 8.1.

9.1.5 Pressure differences

As the case is sealed, under certain circumstances (such as change of altitude) the interior of the **FS/2** may develop a substantial pressure difference compared with the environment. Loosen and then retighten the battery cap.

9.2 Diagnosing and Solving Problems

There are two main classes of problem that you might have.

The first class consists of problems which the **FS/2** reports to you, by displaying an 'error message', a short description of the problem. For example, **`Insufficient disk space`** means that there is not enough space on the disk for an operation.

This class of problems should be quite easy to handle. The error messages produced by MS-DOS are described in the *MS-DOS User's Reference*. The error messages produced by the special **FS/2** utilities are described in

Chapter 10 to Chapter 12. The error messages from third party applications will of course not be included in this guide - see the application's own guides for details.

The second class of problems are those that are not accompanied by an error message. You realise that there's a problem because the **FS/2** doesn't do what the user wants, or does something that the user doesn't want.

Always check that the user has followed the instructions for their application first, to make sure that the error is not theirs.

Problems of this type which may arise with a standard system include:

Symptom	**Cause - remedy**
Won't power up	AC adaptor disconnected or faulty and no internal batteries or batteries discharged. - Recharge or replace as described in section 8.2, then try again. If this does not work, either the batteries or the AC adaptor have failed; contact your local representative.
Screen blank or all dark	The LCD contrast is incorrectly set. - Hold down ⇧ and press ↑ or ↓ until the LCD Screen contents become visible.
Powers up in an application	This will happen if an application was running when the **FS/2** was turned off. - If you want to use an MS-DOS command or a different application, leave the application as described in its user instructions. This will take you to MS-DOS command mode and preserve all your application's files.

Don't know how to leave application	- If the user instructions don't tell you how to leave the application, ask the programmer who wrote it. - If this does not help, press Ctrl Fn Esc, which should take you to MS-DOS command mode. OR reboot by pressing Ctrl Alt Del. (If the program is started automatically by a reboot, press Ctrl Fn Esc during the reboot to prevent this.) - If neither method works, see 'Can't leave application', below.
CAUTION:	**Either method will corrupt any files that the application is writing to at the time, so use them only as a last resort.**
Won't power down	The current application is in 'continuous power' mode, probably because it is performing an operation which should not be interrupted, such as transmitting a file via the serial port. A message should be displayed to this effect. - Wait until the operation has finished and you should be able to power down normally. - If you cannot wait, or believe that something has gone wrong, leave the application as described above, and you should be able to power down normally. - To power down without leaving the application, remove and refit the battery cap (and disconnect the charger if connected). The application will continue normally when you turn on again.

Program runs when you power up	The program has been installed to run automatically, typically by including a command in the file C:\AUTOEXEC.BAT. - If you want to use a different program, leave it as described above, or press Ctrl Esc immediately after turning on. - To stop the program running automatically, delete the appropriate command from the C:\AUTOEXEC.BAT file, or ask your technical support team to do this for you.
Beeps when you press a key	You have pressed an invalid key. A utility is waiting for you to make a selection by pressing one of a particular group of keys. - Press one of the keys indicated on the screen.
Keyboard behaves strangely	A previous application has redefined the keyboard, so that keys have different effects to normal. - If you are in an application, leave it first (see above), then reboot by pressing Ctrl Alt Del.
Misbehaves or locks up when boots	The CONFIG.SYS or AUTOEXEC.BAT files may be corrupted or may execute a program which is corrupted. Hold down the left ⇧, Ctrl and Alt keys immediately after exiting the Welcome screen to rename these files to ZONFIG.SYS and ZUTOEXEC.BAT, so MS-DOS will ignore them while booting.

Can't leave application Or Locks up Or Behaves strangely	Program crash or hardware failure. - Reboot by pressing Ctrl Alt Del OR if this won't work, remove and refit the battery cap (and disconnect the charger, if connected), then turn on again. If normal operation resumes, carry out the checks described in the next section. - Finally, if you have been supplied with instructions for the EMERGENCY HARDWARE RESET (on subsequent pages), try that. If you cannot restore normal operation, contact your technical support team or system supplier.

Report any persistent problems to your technical support team.

Pressing Ctrl C or Ctrl Esc will often abort an application, while Ctrl Alt Del will normally reboot, but either or both may be disabled by an application.

Pressing ⏻ will usually turn off but this may be disabled by an application.

Removing and refitting the battery cap will always turn off, but when you turn on again, the **FS/2** will usually power up in the application that was running when you turned off.

If the computer displays the following message when you reboot:

```
Verify failed sector: xx
Potential data corruption detected
Please contact your system provider
```

Contact your technical support team, or refer to the DISK CORRUPTION instructions, below (if they have been provided to you).

Under normal circumstances the **FS/2** should be very reliable, but if you use it for software development, a user program may crash and 'lock up' the machine. If this happens, try the following emergency breakout procedures. If these do not help, contact your local distributor or Husky Computers.

Emergency breakout

> Use this facility to break out of any application. You may wish to restrict access to the information on this page.

Note: The following description is for the standard English keyboard layout shown at the start of chapter 1. If you are using a different keyboard, press the keys in the corresponding positions; their legends may differ.

If you cannot break out of a program for some reason, the following should always work unless there is a serious hardware malfunction:

1 Turn the **FS/2** off (eg remove and replace the battery cap).

2 Hold down the X and P keys.

3 Press ⓘ briefly and release X and P.

4 The **FS/2** should exit any program and reboot (unless there is a hardware malfunction). You may however require several attempts, as timing is critical.

Emergency hardware reset

> Use this facility to reset a machine on which emergency breakout fails.

1 While holding down both ⇧ keys, press ⓘ. Hold down all three keys for about 4 seconds (until the display goes dark), then release them all.

2 The machine should exit any program and reboot. If it does not, there is a hardware malfunction: contact your system supplier for repairs.

Note: You should then carry out the checks described in the next section, to make sure that the **FS/2** will now operate correctly.

Disk corruption

Use this facility to operate a machine with a corrupted RAM disk.

If the program has corrupted the RAM disk, you will see a message like this when the machine reboots:

```
Verify failed sector: xx
Potential data corruption detected
Please contact your system provider
```

To use the machine you must do one of the following:

1 Type the emergency breakout password (56580) and you will see:

```
Default disk (lose all data) Y/N ?
```

Press [N] to try to boot from the corrupt disk. If the corruption is minor, this may succeed and you can attempt to recover data from the RAM disk, eg by sending it to another computer via the serial port. You should then reformat the RAM disk and check the files, as described for option 1. If the machine still will not boot, you must use another option.

2 Type the emergency breakout password (56580) and you will see:

```
Default disk (lose all data) Y/N?
```

Note: This option will erase all user information from the RAM disk, so only use it if there is no important information on the disk, or if the other options have failed or are not available to you.

Press [Y] to reformat the RAM disk, which will **erase all files**. The following message will be displayed:

```
All data has been erased
Use UTIL to format fixed disk
```

Use the UTIL utility to reformat the RAM disk.

9.3 Checks

If an application has crashed, it may have corrupted other parts of the system. You (or your technical support team) should select MS-DOS command mode and carry out the following simple checks, to make sure that future operation is not compromised.

9.3.1 Communications

The communications configuration may be affected by a crash, and will be indicated when you attempt to use or configure communications using the UTIL application.

Use the UTIL application to check and, if necessary, correct the configuration.

9.3.2 Real Time Clock (RTC)

The RTC may be corrupted, as shown by an incorrect or impossible time or date.

Use the UTIL application to check and, if necessary, correct the time and date.

9.3.3 Files

An application may corrupt any disk files that it was writing to when it crashed or was reset or rebooted. Files open for reading will not be affected. Files are not affected by turning on and off.

If any of these events occur, check what files are written to by the application and, if you have access to recent copies (backups), delete the current versions and use the backups.

If you do not have recent copies, run the application but check the state of the files carefully.

(An application running on a conventional desktop computer may also corrupt any disk files that it was writing to when it crashed or was reset or rebooted. It is actually more likely to corrupt files, because a power failure part way through a write will normally corrupt the file too.)

9.3.4 RAM disk

Any files on the internal RAM disk may also in principle be corrupted by a 'wild' program overwriting the file data or access information (directory and FAT), since these are all held in memory. However, this is very unlikely to happen, since the memory used for the RAM disk is not in the main memory map. It is only likely if an application crashes which has been written especially for the **FS/2** and accesses the FAT or directory directly.

If a RAM disk file does get corrupted, this should be detected the next time you attempt to read it, since these files are protected by checksums. To check, type the following in each directory of drive C:

```
COPY *.* NUL ↵
```

- this makes MS-DOS check that they are readable. If you see any error messages, delete the affected files and reload them from your most recent backups.

If a wild program corrupts crucial information such as the FAT, the entire RAM disk may become unreliable. To check, load the MS-DOS utility CHKDSK onto your search path and type:

```
CHKDSK C: /F ↵
```

If all is well, your screen should look like this:

```
536576 bytes total disk space
344064 bytes in 11 user files
  8192 bytes in bad sectors
184320 bytes available on disk

524288 bytes total memory
476016 bytes free
```

The exact figures depend on the amount of memory fitted, how it is configured, and how many files are on the RAM disk.

If the total memory or disk space are not as expected (check with your technical support team), you should copy any files that seem intact to another computer, then re-format the disk by using UTIL (see Chapter 10).

If you see the message:

```
nnn lost clusters found in nn chains.
Write corrections to disk (Y/N)?
```

then there are files (or parts of files) on the disk which are not recorded in the FAT. Typically, this will be because an application crashed part way through writing a file. Type Y ↵ and they will be converted to files in the root directory, called FILE0000.CHK, FILE0001.CHK, etc. Use the TYPE command to check what these files contain. If a file is simple text (eg a memo you were preparing), you can use it, after giving it a more sensible name. If a file is not text (eg part of a database file), you probably won't be able to use it, so you should delete it. (If you're not sure, ask your technical support team.)

9.3.5 Memory configuration

The **FS/2** memory can be partitioned into two parts: main (MS-DOS) memory and RAM disk. A crashed application may have corrupted this partitioning information. (This is particularly likely if the unit is configured with less than 640K of DOS RAM, which is not recommended.)

To check the partitioning, use the MS-DOS CHKDSK command or the UTIL utility. If it is not as you'd expect, first copy any files from the RAM disk to another computer, then reconfigure the RAM (see section 10.5).

If this does not help, the system configuration information may have become corrupted. Run the UTIL utility and select the **`Format Fixed Disk`** option (see section 10.6). This will set the configuration to standard and reformat the RAM disk.

Chapter 10 The System Utility (UTIL)

This chapter describes the UTIL utility, which provides access to a number of utility functions unique to the **FS/2**. This chapter summarises how to use these functions, for ease of reference; they have also been described in context elsewhere.

10.1 Introduction

The functions provided by UTIL are not intended for everyday use. Indeed, you may never need to use them. For more detailed information on how and why you should use them, see:

Function	**Chapter**
Set time/date	Correcting the time (eg when crossing time zones): Chapter 5, Setting Up If the clock gets corrupted: Chapter 9, Troubleshooting
Format diskette	No longer used
Format fixed disk	If memory or RAM disk gets corrupted: Chapter 9, Troubleshooting Using extra memory: Chapter 15, Accessories
Comms ports	Setting up communications ports: Chapter 13, Introduction to Communications

10.2 Using the utility

To use UTIL, select MS-DOS command mode and type:

```
C:\UTIL ↵
```

This displays the main UTIL menu, like this:

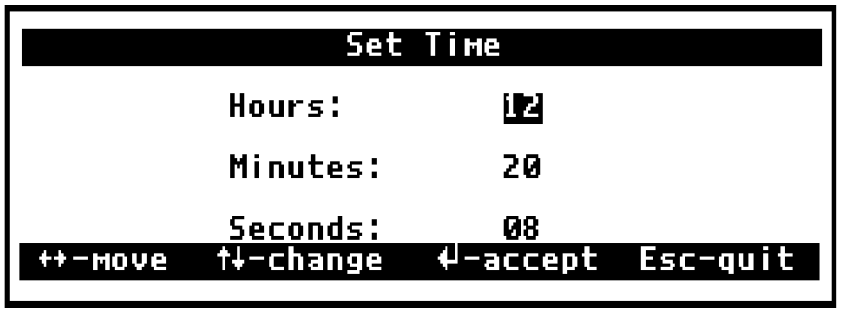
The keys that you can use are displayed at the base of the screen. For example, to select an option, move the highlight to it by using ← or →, then press ↵.

To return to command mode, press Esc.

10.3 Set time

Use this option to set the system time. Note that the same facility is provided by the MS-DOS TIME command.

The screen will look like this:

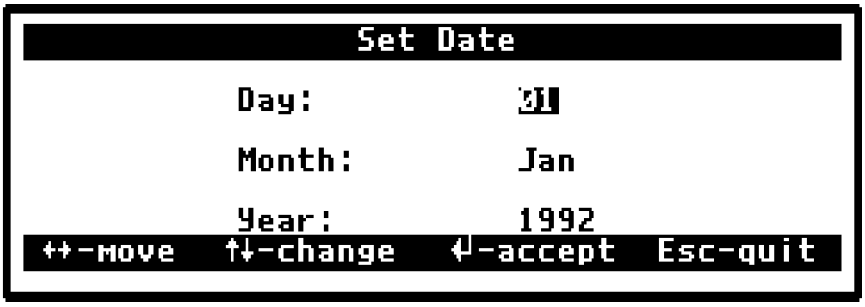


Move the highlight to the time field that you want to change, by using the ← or → key, then adjust the value by using the ↑ or ↓ key. Press ↵ to accept the new time and return to the main UTIL menu, or press Esc to cancel the changes.

10.4 Set date

Use this option to set the system date. Note that the same facility is provided by the MS-DOS DATE command.

The screen will look like this:



Move the highlight to the date field that you want to change, by using the ← or → key, then adjust the value by using the ↑ or ↓ key. Press ↵ to accept the new date and return to the main UTIL menu, or press Esc to cancel the changes.

Note that the **FS/2** adjusts month length for leap years, but does not adjust for local changes such as Summer/Winter (Daylight Saving) time changes.

10.5 Format diskette

This option is no longer used.

10.6 Format fixed disk

Use this option to format the RAM disk or change the way that the **FS/2** RAM is used. You should not need to do this in normal usage, but might if:

- The disk has been corrupted by running a program which crashed.
- The disk has been corrupted by losing power (main batteries or AC adaptor) for more than 7 days at 20˚C (68˚F).
- The disk contains data of a sensitive nature that you wish to destroy.
- The memory size has been corrupted.

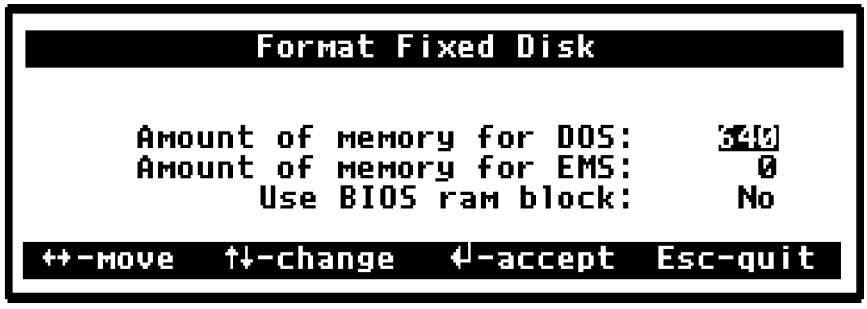
- You have fitted more memory (see section 15.3).

You might also need to use this option to change the partitioning of memory between DOS memory and RAM disk. For example, if you need to increase the RAM disk size to run an application onto it.

The screen will look like this:

To format the disk, press ↑ or ↓ to select **Yes**, then press ↵. To return to the main menu without formatting the disk, press Esc.

You will next be asked to select the memory configuration required:



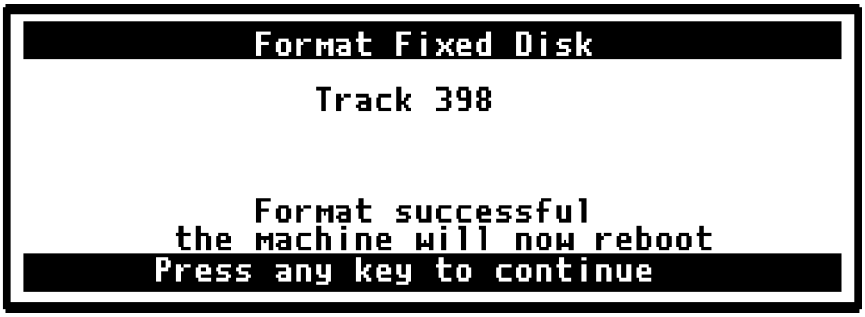
The first option allows you to specify how much of the first 1MByte of memory will be allocated to DOS, up to 640KByte. Any unallocated memory will be allocated to the fixed disk. The more memory you allocate to DOS, the larger the programs you can run.

Note: We recommend that you do not reduce the DOS memory below 640K as this increases the risk of an application writing to the RAM disk area by mistake.

The second option, **`Amount of memory for EMS`**, is no longer used.

The third option allows you to choose between two types of disk format. Set **`Use BIOS ram block`** to **`No`** to produce a more robust format which is better protected against program crashes and illegal memory writes. Set it to **`No`** for a slightly less robust format which has 12KB more disk space available.

Press ⏎ and formatting will begin. When it has finished, a screen like the following will be displayed:



Press any key and the **FS/2** will reboot.

CAUTION: Formatting destroys all user information on the RAM disk. It does not however remove any of the system files, such as the operating system, standard utilities, EDIT and UTIL.

CAUTION: Do not use any other commands (such as the MS-DOS FORMAT command) on the FS/2 to format the RAM disk.

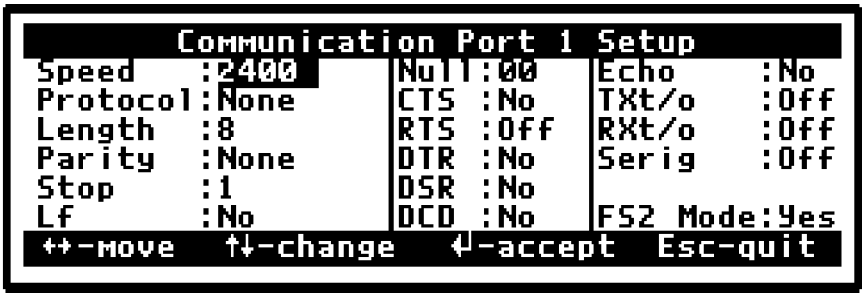
10.7 Communication Port 1/2 Setup

Use these options to select and configure **FS/2** (or Husky) communications for COM1 or COM2 (the main serial ports), or to restore IBM communications.

FS/2 communications has the following advantages:

- support for protocols (XON/XOFF and any optional protocols installed), providing more secure data transfer
- configurable handshaking, to suit a wide variety of devices and connection methods
- faster data transfer (up to 38,400 Baud) for efficient communications
- data buffering for reliable fast transfer
- compatibility with other Husky handheld computers (such as **Husky Hunter 16**)

This screen will look like this:



This shows the current configuration of the selected port, and allows you to alter it by using the cursor keys.

To restore IBM communications, simply set **`FS2 Mode`** to **`No`** and press ↵.

To select Husky (**FS/2**) communications, simply set **`FS2 Mode`** to **`Yes`**, set the other parameters as required, and then press ↵.

To cancel any changes you have made, press Esc.

You will normally simply select a configuration to suit the device that is connected to the port. For more details of the significance of the various options, see Chapter 13.

The configurations that you select will normally remain in force until you use this option again. However, IBM-style communications will be resumed if you use an application or command (such as **`MODE COM1`**) which re-initialises communications; to re-select Husky (**FS/2**) communications, simply select this option again.

Standard (MS-DOS) applications which control the port hardware directly (such as certain communications packages) will also ignore the configuration set using this option.

Chapter 11 The HOT Key

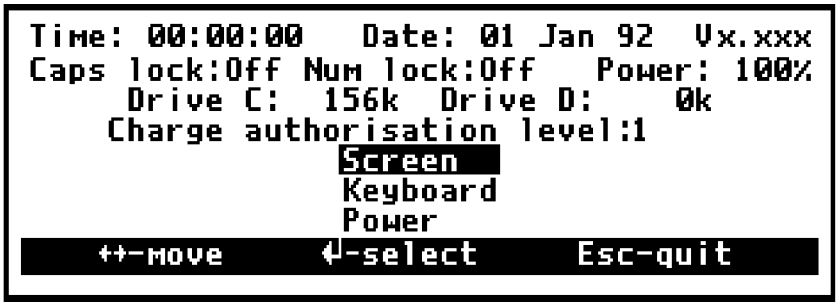
This chapter summarises the facilities provided by the **FS/2** HOT key, which you can use to check or change certain key aspects of the **FS/2** set-up. Particular uses are described in more detail as appropriate elsewhere in this manual.

Note: To use the HOT key, you need the ❀ key, which toggles between PAW and backlight (✲) functions. If this key operates the backlight, toggle it back to PAW by holding down both ⇧ keys and pressing the key immediately above ↵ (⊙ in the standard English layout).

11.1 Introduction

To use the HOT key, press ❀ H. You do not have to be at the DOS prompt to use the HOT key. For example, you can use it while in the middle of an application, without interfering with its operation in any way.

The HOT key displays a screen like this:



This screen displays summary status information about the **FS/2** and provides you with facilities to adjust the screen, keyboard and (optionally) power settings.

The bottom line of the screen shows which keys to use. For example, to use the keyboard facilities, move the highlight to the **Keyboard** option by using the ← or → keys, then press ↵ to select it.

To return to the normal screen display, press Esc or press ❀ H again.

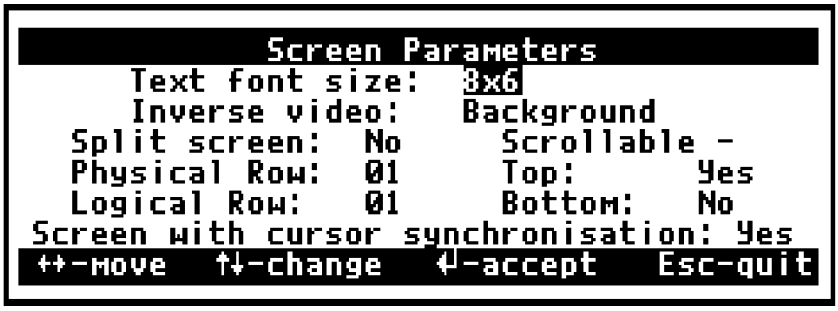
11.2 Status information

The status information is as follows:

- The time and date
- The state of the Caps Lock and Num Lock keys
- The percentage power remaining
- The free space remaining on drive C (RAM disk) and drive D.
- The charge authorisation level. This indicates whether you can recharge the internal batteries by using the **Husky** AC adaptor. For details, see section 8.2.2.

11.3 Screen option

The **Screen** option displays the following:



Move the highlight to the options you want to change by using the ← and → keys, then adjust the displayed value by pressing the ↑ or ↓ keys. When you have finished, press ↵ to accept the changes or Esc to cancel them.

11.3.1 Text font

The **FS/2** can display text on the LCD in different sizes, e.g. 16x12, 8x12, 11x8, 8x8, 8x6 and 6x4 (all sizes in pixels). The smaller characters allow you to display more text at a time, but you will probably find the larger characters easier to read.

You can adjust the text size at any time without ‘confusing’ your application.

If changing the text size has no apparent effect, your application is using the display in graphics mode, which does not support this feature.

11.3.2 Inverse video

If you are using an application which displays text using a variety of text colours or other attributes (such as high intensity), you may be able to improve the display by telling the **FS/2** to use 'inverse video' for these unsupported attributes. Either ask your technical support team which setting to use, or experiment until you achieve the best result.

11.3.3 Split screen

If an application maintains a status, message or menu line separate from the main work area on the screen, you can tell the **FS/2** to display it permanently on the LCD by using the split screen facility. This splits the CGA and LCD into two parts (windows), displaying information from the top CGA window in the top LCD window, and the bottom CGA window in the bottom LCD window.

To do this, set **`Split Screen`** to **`Yes`**, then set **`Physical Row`** to the line (1..10) where you want to split the LCD and **`Logical Row`** to the line (1..25) where you want to split the CGA.

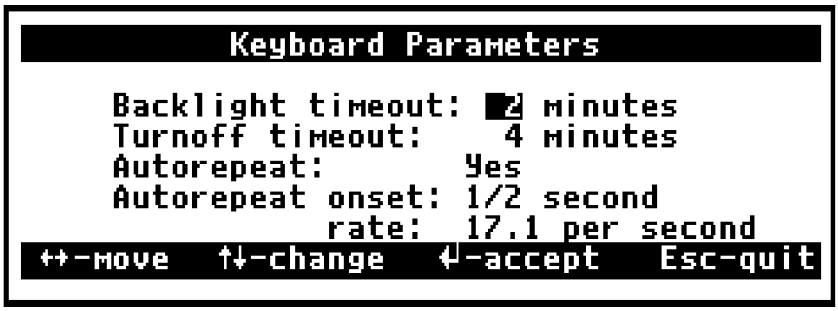
You can also control scrolling for each window by changing the values displayed against **`Top`** and **`Bottom`**. If you set this to **`Yes`**, the LCD window will scroll to show anything you type while the cursor is in that part of the CGA. If you set this to **`No`**, the LCD window will not scroll automatically, although you can scroll both windows by using the viewing keys.

11.3.4 Cursor synchronisation

This option allows you to decide whether the LCD should scroll automatically to keep the cursor visible, or only when you operate the 'looking keys' (see section 7.3.3). Leave this set to **`Yes`** unless you encounter problems with an application.

11.4 Keyboard option

The **`Keyboard`** option displays the following:



Move the highlight to the options you want to change by using the ← and → keys, then adjust the displayed value by pressing ↑ or ↓ key. When you have finished, press ↵ to accept the changes or Esc to cancel them.

11.4.1 Backlight timeout

This value controls how long the backlight will stay turned on, if a user does not press any keys. You can set it to between 1 and 5 minutes, or disable it entirely. The default is 2 minutes.

If the backlight is turned off by a timeout, it turns on again as soon as the user presses a key. This timeout is mainly provided to help save battery power when a user forgets to turn the backlight off!

11.4.2 Turnoff timeout

This value controls how long the **FS/2** will stay turned on, if a user does not press any keys and communications is not active. You can set it to between 2 and 60 minutes, or disable it entirely. The default is 5 minutes.

This timeout is mainly provided to help save battery power when a user forgets to turn off! Remember that a user can normally turn on again and continue exactly where they left off.

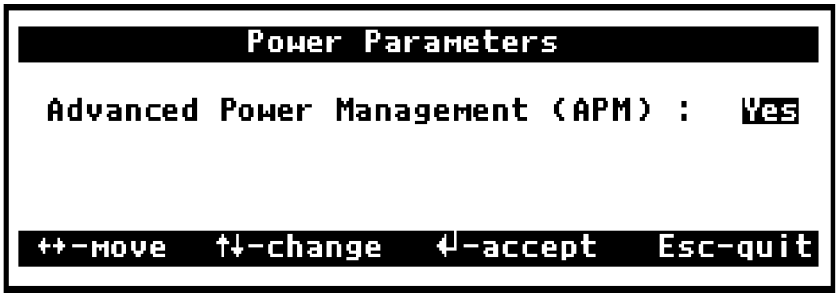
11.4.3 Autorepeat

The onset value is the delay before a key will start to autorepeat if left pressed. The rate is the number of depressions per second which will be 'typed' by

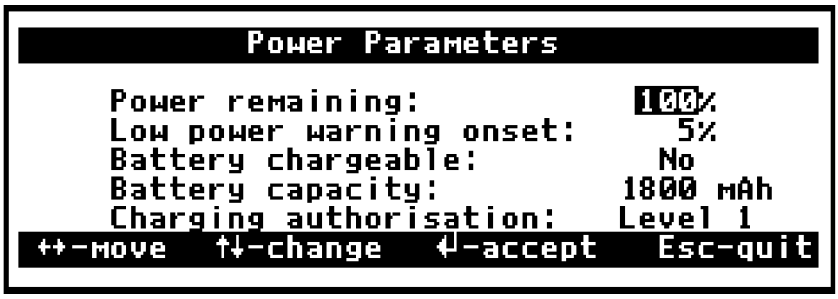
autorepeat. You can set the onset to 1/4, 1/2, 3/4 or 1 second. You can set the rate to between 2 and 30 characters per second. The default delay is 0.5 seconds and the default repeat rate is 17.1 characters per second.

11.5 Power option

This option allows you to switch between SPM and APM modes and configure APM mode, but may be disabled by the application. If available, selecting it displays the following:



To change the power mode, use ↑ or ↓ to **Yes** or **No** and press ↵. If you selected SPM mode, this returns to the main screen. If you selected APM mode, this will display a screen like this:



Move the highlight to the options you want to change by using ← or →, then adjust the displayed value by pressing ↑ or ↓. When you have finished, press ↵ to accept the changes or Esc to cancel them.

11.5.1 Power remaining

You can use this option to change the percentage power remaining, usually after fitting new batteries, or changing battery type.

If you are using rechargeable batteries, the power level is updated automatically each time you recharge, so you should not need to use this.

11.5.2 Low power warning onset

The **FS/2** will issue warning messages and turn off automatically when the percentage power remaining falls below a critical level. Use this option to change this level.

11.5.3 Battery chargeable

Use this option to enable or disable charging. (You can only enable charging if the charging authorisation allows it ie is set to 2, 3 or 4.)

11.5.4 Battery capacity

Use this option to tell the **FS/2** the usable capacity of the fitted batteries, so that it can monitor the power remaining correctly. Typical A-size NiCads have a usable capacity of 1000-1400mAh. Typical alkalines have a usable capacity of about 1800mAh. If the manufacturer quotes a nominal capacity, set the capacity to 80% of this (or less, if heavy loads are expected).

11.5.5 Charging authorisation

If it is fitted with rechargeable batteries, the **FS/2** can be recharged via the **FS/2 AC adaptor**, providing the charging authorisation is set to a value other than 1.

Do not change the charging authorisation level unless you are **SURE** you know what you are doing. See section 8.2 for full details.

Chapter 12 The Editor

This chapter describes EDIT, the **FS/2** text editor which is available on diskette from your supplier. Before you can use it you must load it onto the **FS/2**, eg by using HCOM.

Note: To use many editor facilities, you need access to the Ctrl key. This key is available in the developer (default) keyboard mode, but not the user keyboard mode. To toggle keyboard modes, hold down both ⇧ keys and press the key immediately above ↵ (⊙ in the standard English layout).

12.1 Introduction

EDIT is quick and easy to use, providing a wide range of screen-editing functions. You can use EDIT to write, alter or examine standard ASCII text files, such as CONFIG.SYS and batch files, and GWBASIC programs that have been saved in ASCII form (ie by using the command **`SAVE "name", A`**).

12.2 Selecting EDIT

To use the editor, select MS-DOS command mode and type:

`EDIT` ***`[filename] [options]`*** ↵

Where *filename* is the name of the file to edit or create (see section 12.3) and *options* can be used to change behaviour of the editor (see section 12.4). For example:

```
EDIT C:\DATA\MYFILE.TXT /KEY /60 ↵
```

12.3 File handling

If you specify a filename in the EDIT command, and the file exists already, it will be loaded into memory for you to edit. If the filename includes a DOS drive or pathname, this drive or directory will also be used as the default drive and directory for all file operations within EDIT.

If you do not specify a drive or pathname, the current drive and directory are assumed. If you omit the extension, TXT will be assumed. If you do not specify a filename, EDIT will assume the filename **`NONAME.TXT`**.

EDIT uses the free DOS memory for the file you are editing, so this dictates the maximum size file you can edit. If a file is too large to edit, the following message will be displayed:

```
Disk read incomplete- file too big
```

and you will only be able to edit the first part of the file. If you want to do this, make sure that you save it with a different name, or you will lose the remainder of the file.

If your edits increase the size of the file to the limit of available memory, you will see the message:

```
Short of memory- save file NOW!
```

If you want to continue editing the file, either split it in two (by using the BLOCK WRITE command), or delete some text before carrying on.

Editing takes place in memory, so it has no effect on the disk file until you use the SAVE command. You can save the file with the same name, or use a different name, drive or path.

12.4 EDIT options

You can alter various aspects of EDIT's behaviour by including options in the EDIT command. These are as follows:

Option	Description
`/IGNORE`	When searching for text, EDIT will normally not match capital and small letters. Use this option to ignore case during searches, so that, for example, searching for **`the`** will match **`the`**, **`The`**, **`THE`**, etc.
`/LF`	EDIT normally stores the ↵ key as CR-LF character pair (ASCII 0DH, 0AH). Use this option to store it as a CR character (ASCII 0DH).
`/WRAP`	Lines which are longer than the LCD will normally extend to the right of it, so you must use the cursor keys to view the line ends. Use this option to turn wrapping on, so that text will be formatted to fit in the LCD window.

/TAB TABs are normally stored in the file as a number of spaces. Use this option to store them as TAB characters (ASCII 09H).

/60 EDIT normally uses the 8x6 font, displaying 8 lines of 40 characters on the LCD screen. Use this option to select the smaller 6x4 font, to display 10 lines of 60 characters.

/KEY EDIT normally uses the current keyboard mode. Use this option to force the default keyboard.

/BROWSE EDIT normally allows editing. Use this option to select browse mode, which prevents editing.

To select an option, include it in the EDIT command after the filename, separated by a / character. You can type options as capitals or small letters, abbreviate them by supplying just the first one or two characters, and can use them in any combination or order, as long as they are separated by / characters.

For example, to select a 60-character screen, force the default keyboard and disable wrapping, type:

EDIT *filename* /60/KEY/WRAP ↵

or even:

EDIT *filename* /6/K/W ↵

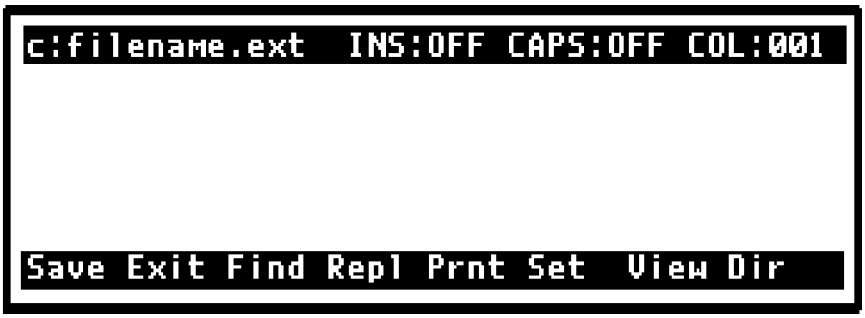
You can also select some of these options from within EDIT by using the SET command (see later).

You can also change the line wrap, font, line delimiter and case ignore settings by using the SET command (see later), once EDIT has loaded.

12.5 Editing screen

The normal mode for the LCD displays 8 lines of 40 characters, but the 60 option displays 10 lines of 60 characters.

On entry to EDIT (in the normal 40-character mode), if the specified file does not already exist, the screen will look like this:



The top line is the **Status Line**. It contains the following information:

`c:filename.ext` This shows the name of the file you are editing.

`INS:ON` This shows whether character insert is on or off.

If insert is on, any text typed will be inserted at the cursor position and any text already present will move to make room.

With insert off, the display will show:
`INS:OFF`
In this case, typing will overwrite existing text.

`CAPS:OFF` This shows the state of the CAPS LOCK function.

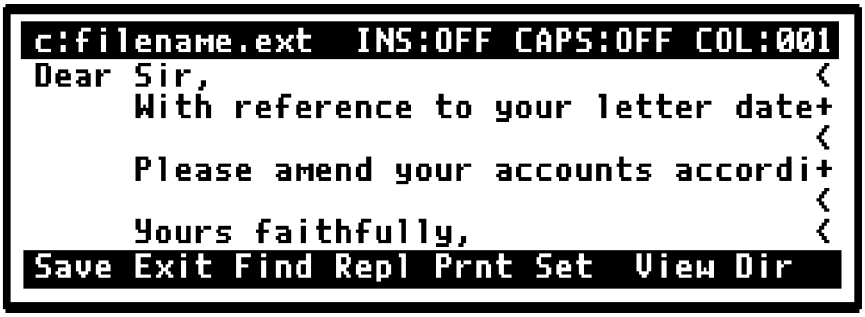
Note: In CAPS LOCK mode, alphabetic keys type capitals unless used with ⇧, when they type lowercase letters. This is NOT a 'Shift Lock' function.

`COL:001` This shows the column of the virtual screen which the cursor is in. It is in the range 1 to 255. As the cursor moves, it is kept updated and may be used for aligning tables, indents in text, etc.

Column 1 is the left of the virtual screen. Column 255 is the extreme right of the virtual screen.

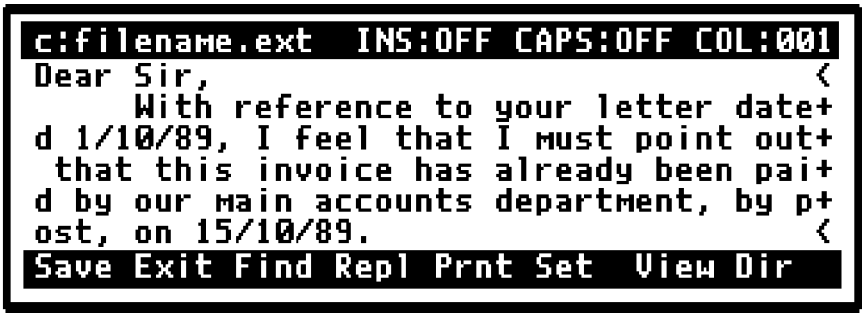
The bottom line is the **Function Line**. This shows the commands performed by pressing the function keys F1 to F10. F1 to F10 can be typed by using 🐾 1, 🐾 2 etc, using 🐾 0 for F10. F1 to F4 can also be typed by using F1 to F4. These and the other editing functions are described later in this chapter. The function line is also used to display prompts and messages.

The lines between the status line and function line are called the **Edit Area**. The edit area displays the text you are working with. When you enter EDIT, if the file exists, you will see its first few lines in the edit area, like this:


c:filename.ext INS:OFF CAPS:OFF COL:001
Dear Sir,
With reference to your letter date+
Please amend your accounts accordi+
Yours faithfully,
Save Exit Find Repl Prnt Set View Dir

This is the display with line wrapping disabled and the 8x6 font, which shows only the first 39 characters of any lines which are wider than the LCD screen.

If you have specified the WRAP option, any lines which are longer than the width of the LCD will be continued on the next LCD line, like this:


c:filename.ext INS:OFF CAPS:OFF COL:001
Dear Sir,
With reference to your letter date+
d 1/10/89, I feel that I must point out+
that this invoice has already been pai+
d by our main accounts department, by p+
ost, on 15/10/89.
Save Exit Find Repl Prnt Set View Dir

The last column of the edit area contains characters which indicate the line length, as follows:

Character	Significance
<	no more data to right (ie all of the line is visible on this line of the LCD)
+	more data to the right (or on next screen line, if line wrapping is on)
B	line contains the block start marker (described later)
K	line contains the block end marker (described later)

If there is more data to the right, you can view it with line wrapping disabled by using the ⊖ key.

12.6 Facilities

Text is entered at the cursor position, which can be moved at will through the file. You can enter lines of up to 232 characters; if a line is longer than the width of the LCD, with wrapping enabled, it will simply continue on the next screen line.

To end a line, press ⏎. This is normally stored in the file as CR-LF (0DH, 0AH), but the LF option will make EDIT store it as the single character CR (0DH).

Remember that you're working with a temporary copy of the file: the disk is not updated until you use the SAVE command. This means that you can abandon any changes you have made by leaving EDIT without saving the file.

Commands are executed by typing certain keypad, function and control keys. These provide the following facilities:

Typing mode

CHARACTER INSERT	Switch between overtype mode (typed characters replace characters at the cursor) and insert mode (typed characters are inserted before text at the cursor)

Cursor movement

CURSOR KEYS	Move up/down/left/right a character/line at a time

WORD SKIP	Move left/right a word
TAB	Move right to the next tab stop (normally every 8 columns)
LINE START/END	Move to the start or end of the line

Screen movement

PAGE UP/DOWN	Scroll up/down a screenful
FILE START/END	Scroll to the start/end of the file

Searching

FIND	Move to the next occurrence of the specified text
REPLACE	Replace the next occurrence of the specified text

Deleting text

DELETE RIGHT	Delete the character at cursor
DELETE LEFT	Delete the character to the left of the cursor
WORD DELETE	Delete from cursor to the next word
DELETE LINE	Delete the current line
UNDELETE	Reverse the last simple delete operation (not BLOCK DELETE)

Block operations

BLOCK MARK	Define block start/end
BLOCK MOVE	Move marked block
BLOCK COPY	Copy marked block
BLOCK DELETE	Delete marked block
BLOCK WRITE	Write marked block to another file

File operations

SAVE	Save the file to disk and exit
EXIT	Exit without saving the file
READ FILE	Insert another disk file at cursor position
DELETE FILE	Delete a file
DIRECTORY	Display a directory

Printing

PRINT SCREEN	Print edit area to COM1

VIEW FILE	Display overview of file contents

Settings

COMMAND OPTIONS	Specify options in EDIT command (see section 12.4)
SET	Change settings from within EDIT

The words in capitals are the command names, which are used to identify the commands throughout this chapter. The keystrokes used to invoke the commands are summarised in section 12.7. The commands are described in more detail in the remainder of this chapter.

Note: EDIT only uses a small area of the CGA display, corresponding to the area of the LCD screen, so there is no point in using the viewing keys (🐾←, 🐾→, etc) to move the LCD window over the CGA as the rest of the CGA is blank; use the cursor and scrolling keys instead.

12.7 The commands

The editing facilities are invoked by typing special keys, as follows. Otherwise, the keyboard behaves exactly as described in Chapter 5.

To interrupt most commands, press the Esc key. (The few exceptions are indicated in the individual command descriptions.)

12.7.1 Control Keys

You can type editing commands by using Control codes (Ctrl A, Ctrl B, etc), which are based on those used in the industry-standard wordprocessor WordStar:

Key	Command
Ctrl A	Skip left
Ctrl B	Not used
Ctrl C	Page down
Ctrl D	Cursor right
Ctrl E	Cursor up
Ctrl F	Skip right

Ctrl G	Delete right
Ctrl H	Delete left
Ctrl I	TAB
Ctrl J	Not used
Ctrl K	Block commands
Ctrl L	Not used
Ctrl M	CR
Ctrl N	Not used
Ctrl O	Not used
Ctrl P	Not used
Ctrl Q S	Line start
Ctrl Q D	Line end
Ctrl R	Page up
Ctrl S	Cursor left
Ctrl T	Word delete
Ctrl U	Undelete
Ctrl V	Character insert
Ctrl W	File start
Ctrl X	Cursor down
Ctrl Y	Line delete
Ctrl Z	File end

12.7.2 Function Keys

The commands performed by the function keys (🐾 1, 🐾 2 etc) are as follows.

Key	Command
F1 or 🐾 1	Save file
F2 or 🐾 2	Exit
F3 or 🐾 3	Find

F4 or Replace
4
5 Print screen
6 Set
7 View file
8 Directory
9 Not used
0 Not used

Their functions are also indicated by legends on the bottom line of the screen (the **Function Line**).

12.7.3 Other Keys

A number of other keys also have special effects within EDIT:

Key	Command
Ins	Character insert
Ctr	Delete left
Del	Delete right
PgUp*	Page up
PgDn*	Page down
Home	File start
End	File end

Note: Keys marked * are not available in the default keyboard.

BLOCK COPY: Ⓚ Ⓒ

Form

Ctrl Ⓚ Ⓒ

Use

BLOCK COPY copies a block defined by using BLOCK START and BLOCK END, to the current cursor position.

Notes

This command does not affect the original block, except that the **copy** of the block is left marked.

You cannot copy a block into itself ie the cursor must not be within the block when you select the BLOCK COPY command.

If you attempt to copy a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK DELETE: Ctrl Ⓚ Ⓨ

Form

Ctrl Ⓚ Ⓨ

Use

BLOCK DELETE deletes the block defined by using BLOCK START and BLOCK END.

Notes

BLOCK DELETE removes the block text and the block markers from the file. The cursor may be positioned within the block; its position is immaterial.

You cannot reverse a BLOCK DELETE by using the UNDELETE command.

If you attempt to delete a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK MOVE: Ctrl K V

Form

Ctrl K V

Use

BLOCK MOVE moves the block defined by using BLOCK START and BLOCK END, to the current cursor position.

Notes

The block remains defined ie it is still marked.

You cannot move a block into itself ie the cursor must not be within the block when you select the BLOCK MOVE command.

If you attempt to move a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK START/END: Ctrl K B, Ctrl K K

Form

Ctrl K B BLOCK START
Ctrl K K BLOCK END

Use

BLOCK START and BLOCK END are used to define a block of text so it can be moved, deleted, copied, or written using the other block commands.

Notes

The extent of the block is shown by reversing the text within it.

If you have defined the block start but not the block end, the block end is assumed to be the end of the current line (ie the next CR). To define a different end, use the BLOCK END command.

The start of a block is also indicated by a `B` in the last column of the screen; the end is marked by a `K`.

The start of a block must come before the end! If not, when you try to use the block, you will see the error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK WRITE: Ctrl K W

Form

Ctrl K W

Use

BLOCK WRITE writes a copy of the block defined by using BLOCK START and BLOCK END, to a named file. It prompts you for the name by displaying:

```
Write block file name>
```

Type the filename to write to. EDIT will assume the extension .TXT if you do not type one. If you do not specify a drive or path, EDIT will write the file to the current drive and directory.

Notes

The block remains unaffected by use of BLOCK WRITE; it is not moved and is still marked. The saved file overwrites any existing file with the same name, without warning.

If you attempt to write a block when there is no block defined, you will see the following error message:

No block marked... press any key

Press any key to carry on.

CHARACTER INSERT: Ins

Form

Ins or Ctrl V

Use

CHARACTER INSERT switches between insert mode and overtype mode. The mode is shown on the top line. For example:

INS:ON

In overtype mode, characters entered replace (overtype) existing text.

In insert mode, text is inserted before the cursor position. This is useful for adding characters to the middle of a line.

Notes

There are two exceptions to the above rule: ↵ and the TAB command.

In overtype mode, ↵ simply moves the cursor to the beginning of the next line and Ctrl I moves to the next tab stop (or inserts spaces, if at the end of a line). However, if the cursor is at the end of a line (ie a ↵ character), any characters typed will be inserted before the end of the line rather than overtyping it.

In insert mode, ↵ breaks the line at the cursor, while Ctrl I inserts a TAB character or sufficient spaces to move to the next tab stop (depending on the use of the TAB option; see section 12.4).

Even in overtype mode, both keys will insert text if the cursor is at the end of the file.

CURSOR KEYS: ↑, ↓, ←, →

Form

↑ or Ctrl E - CURSOR UP
↓ or Ctrl X - CURSOR DOWN
← or Ctrl S - CURSOR LEFT
→ or Ctrl D - CURSOR RIGHT

Use

These keys move the cursor a character or line at a time in the indicated direction. They may be used to move the cursor to any character within the text, where you can begin typing, deleting or other editing operations.

They cannot move the cursor to before the beginning of the file or after the end of the file, but can be used to move past the end of a line.

Notes

CURSOR LEFT will move to the end of the previous line if the cursor is at the start of the line. Similarly, CURSOR RIGHT will move to the start of the next line if the cursor is at the end of a line.

DELETE FILE: Ctrl K E

Form

Ctrl K E

Use

DELETE FILE deletes a file from the current or specified directory. It displays the prompt:

```
Erase file>
```

Type the filename, including a drive or path if required. If you simply type a filename, the current directory will be assumed.

To prevent the deletion, press Esc before the disk access.

DELETE LEFT/RIGHT: ⌫, Del

Form

⌫ or Ctrl H - DELETE LEFT
Del or Ctrl G - DELETE RIGHT

Use

DELETE LEFT deletes the character to the left of the cursor, then moves the cursor left.

DELETE RIGHT deletes the character under the cursor, without moving the cursor.

Notes

If you delete a ◀, this will join that line with the next.

CAUTION: If you hold down a delete key, it will 'auto-repeat', storing delete commands, so that when you release the key, several more deletes will be performed. Do not hold a Delete key down. Instead, use single key depressions, LINE DELETE or BLOCK DELETE.

To insert the deleted text at the cursor, use UNDELETE.

DIRECTORY: 8

Form

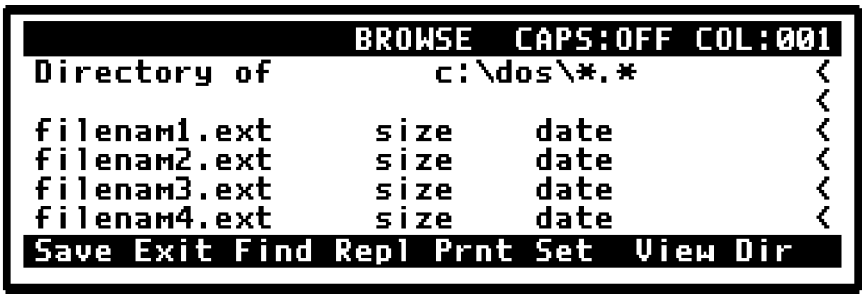
8

Use

DIRECTORY displays a directory of the current or specified drive and directory. It displays a prompt like this:

```
Directory>
```

To list the current directory just type ↵. To list another directory, type its pathname, followed by ↵. To list only certain files, use wildcards (see your MS-DOS manual). This displays a directory in the following form:



Use the PgUp and PgDn keys to scroll the directory. Press ☙ 8 or ☙ 2 to return to editing.

EXIT: ☙ 2, F2

Form

☙ 2 or F2

Use

EXIT quits EDIT. If you have not saved the file since making any changes, it displays the following prompt:

```
Exit editor (Y/N) ?
```

Press N to continue editing.

Press Y to leave the editor without saving the file. Note that if you do this, any changes you have made to an existing file will be lost; if you were creating a file, it will be lost entirely.

To save the text, use the SAVE command.

FILE START/END: Home, End

Form

Home or Ctrl W - FILE START
End or Ctrl Z - FILE END

Use

These commands move the cursor to the very beginning or end of the file.

FIND: ⌘3, F3

Form

⌘3 or F3

Use

FIND is used to search the file for a specified string. Searching starts from the cursor position and continues to the end of the file. To search the whole file, move to the start first (by using the FILE START command).

FIND displays the following prompt on the function line:

```
Find>
```

Or, if you have already specified a search string, it will be displayed for you to edit. Type the text to look for (up to 50 characters) or edit the displayed text, then press ⏎. Be exact, as FIND will only find an exact match (including use of spaces). Normally, FIND will consider capital and small letters as different, but you can change this by using the **IGNORE** option in the EDIT command, or by using the SET command to select case-ignore. If the text is split over the end of a screen line FIND will still find it correctly.

While searching is in progress the following message will be displayed on the function line:

```
Searching...
```

If an exact match is found then the cursor is moved to its first character.

If no match is found, the following message is displayed on the function line:

```
Search failed...
```

and the cursor remains where it was.

Notes

To halt the search, press Esc.

To find and replace, use the REPLACE command.

LINE DELETE: Ctrl Y

Form

Ctrl Y

Use

LINE DELETE deletes the line on which the cursor is placed. The cursor can be anywhere within the line.

Note that LINE DELETE only deletes a single screen line. To delete an entire sentence or paragraph, you will probably need to use it several times.

LINE START/END: Ctrl Q S, Ctrl Q D

Form

Ctrl Q S - LINE START
Ctrl Q D - LINE END

Use

These keys move the cursor to the beginning or end of the current line.

PAGE UP/DOWN: PgUp, PgDn

Form

PgUp or Ctrl R - PAGE UP
PgDn or Ctrl C - PAGE DOWN

Use

These keys are used to scroll the text, a screenful (six lines) at a time. (This is quicker than using ↑ and ↓.)

If the cursor is not on the bottom screen line, PAGE DOWN will put it there. If the cursor is on the bottom line, PAGE DOWN will move the LCD screen six lines nearer the end of the file.

Similarly, PAGE UP will place the cursor on the top screen line, or move the LCD screen 6 lines nearer the start of the file.

Notes

These commands are useful for scanning quickly through files.

PRINT SCREEN: 🐾5

Form

🐾5

Use

Prints the current contents of the screen to COM1.

READ FILE: Ctrl K R

Form

Ctrl K R

Use

READ FILE inserts a specified file at the cursor position. It displays the following prompt:

```
Read block file name>
```

READ FILE will normally read a file from the current directory. To read a file from a different directory include the drive and/or path before the filename.

If you do not specify an extension, .TXT will be assumed.

Notes

If the read fails for any reason (eg no such file or drive not ready), an error message will be displayed. Refer to section 12.8 for details.

REPLACE: 4, F4

Form

4 or F4

Use

REPLACE is used to search the file for a specified string and replace it with a second string. Searching starts from the cursor position and continues to the end of the file. To search the whole file, move to the start first (by using the FILE START command).

REPLACE displays the following prompt on the function line:

Find>

Or, if you have already used REPLACE or FIND, it will display the previous search string for you to edit. Type the text to look for (up to 50 characters), or edit the displayed text, and press ↵. Be exact, as REPLACE will only find an exact match (including use of spaces). Normally, REPLACE will consider capital and small letters as different, but you can change this by using the **IGNORE** option in the EDIT command, or by using the SET command to select case-ignore. If the text is split over the end of a screen line REPLACE will still find it correctly.

REPLACE then prompts for the replacement text:

Replace>

If you have already use REPLACE, it will display the previous replace string for you to edit. Type or edit the string, which may be up to 50 characters, ending with ↵ and searching will being.

While searching is in progress the following message will be displayed on the function line:

Searching...

If an exact match is found then the found string is replaced by the replacement string cursor and the cursor is moved to its first character.

If no match is found, the following message is displayed on the function line:

Replace failed...

and the cursor remains where it was.

Notes

To halt the search, press Esc.

To search without replacing, use the FIND command.

SAVE: 1, F1

Form

1 or F1

Use

SAVE saves the text to a disk file. It displays the following prompt:

```
File name> filename.ext
```

Where **filename.ext** is the filename specified in the EDIT command or a previous SAVE command. To save the file with this name, just press ↵. To save it with a different name, edit the displayed name and then press ↵. Note that if you do not specify a path, this will save the file to the current directory.

If you do not specify an extension, .TXT will be assumed.

Notes

If the save fails for any reason (eg disk full or file is read-only), an error message will be displayed. See section 12.8 for details.

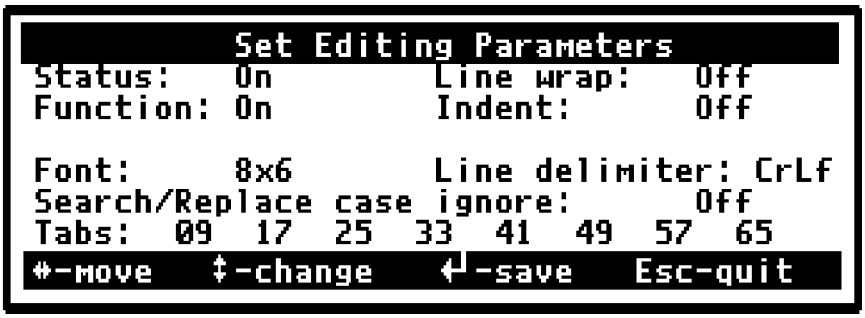
SET: 6

Form

6

Use

This command can be used to examine or change the optional settings which change the behaviour of EDIT. It displays a menu like this:



To change a setting, press ⇐ or ⇒ to move to it, then press ⇑ or ⇓ until the setting is correct.

When you have finished, press ↵ to use the change settings, or Esc to ignore them.

The options are as follows:

Status — Use the top line for a status display (On) or for text (Off). The default is On.

Function — Use the bottom line for function key display (On) or for text (Off). The default is On.

Line wrap — Display just the first 39 (8x6 font) or 59 (6x4 font) characters of each line (Off) or wrap each line onto the next screen LCD line (On). The default is Off.

Indent — Move the cursor to column 1 each time ↵ is pressed (Off) or to a specified column (1..9) if in insert mode. The default is Off.

Font — Use the standard text font (8x6) to display 8 lines of 40 characters or use the compressed font (6x4) for 10 lines of 60 characters. The default is 8x6.

Line delimiter — When you press ↵, place a CR character or a CR plus LF in the file.

Search/Replace case ignore	Require an exact match (Off) or ignore case (On) for SEARCH and REPLACE functions. The default is Off.
Tabs	Defines the 8 tab stops that are used when you press the TAB key (Ctrl I). Tab stops are initially set every 8 columns (ie 9, 17, 25, 33 etc).

Notes

You can also specify the line wrap, font, line delimiter and case ignore settings by using EDIT command line options (see section 12.4).

If you have already used TABs in the file, changing the tab settings will move any TABs which were entered as TAB characters, but will have no effect on TABs which were entered as spaces. (See the description of the TAB command for more details.)

TAB: Ctrl I

Form

Ctrl I

Use

TAB moves the cursor to the next tab stop, making it easier to indent text and lay out tables. Tab stops are normally set every 8 characters ie at column 9, 17, 25, etc, but you can change the spacing by using the SET command. (If there is no tab stop to the right of the cursor, the cursor will not move.)

The way that TAB moves the cursor depends on the typing mode and use of the TAB option in the EDIT command.

- In insert mode, TAB normally inserts sufficient spaces to move the cursor (and text to the right of the cursor) to the next tab stop on the current line. However, if tabs have been turned on by using the TAB option in the EDIT command (see section 12.4), TAB will simply insert a TAB character (ASCII 09H), which moves the cursor and text to the next tab stop.

- In overtype mode, TAB normally simply moves the cursor to the next tab position on the current line without moving the text or inserting anything in the file, but it will insert sufficient TAB characters or spaces (depending on use of the TAB option) to move to the next tab stop if that is beyond the current line end.

Notes

TABs inserted as TAB characters will move if the tab stops are moved by using the SET command. TABs inserted as spaces will not move.

Another way to indent text is to use the indent option provided by the SET command.

UNDELETE: Ctrl U

Form

Ctrl U

Use

Inserts the text deleted by the previous DELETE LEFT, DELETE RIGHT, LINE DELETE or WORD DELETE command. This will reverse the effect of the command if the cursor is in the same place.

Notes

UNDELETE simply inserts the text deleted by the previous delete command. It will NOT reverse a BLOCK DELETE command.

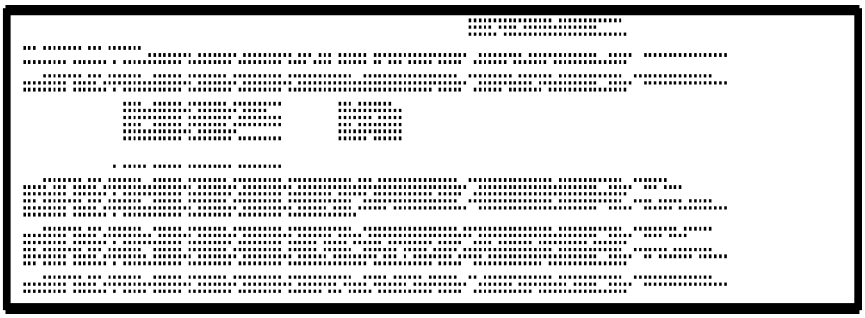
VIEW FILE: 7

Form

7

Use

VIEW FILE tells EDIT to ‘zoom’ the LCD, to show a graphics representation of the file contents starting from the current LCD screen position, like this:



This shows each non-space character as one black plus one white pixel, and each space character as two white pixels, allowing the LCD to represent up to 120 characters per line (if a line is longer than this, the excess characters are not displayed.) Each line of pixels is separated from the next by a blank line, so the LCD can show the contents of 32 text lines.

In VIEW FILE mode, you cannot use any other commands. To return to the normal view and continue editing, press Esc or ↵.

WORD DELETE: Ctrl T

Form

Ctrl T

Use

WORD DELETE deletes from the cursor to the start of the next word.

Notes

To insert the deleted text at the cursor position, use UNDELETE.

WORD SKIP: Ctrl A, Ctrl F

Form

Ctrl A - SKIP LEFT
Ctrl F - SKIP RIGHT

Use

SKIP RIGHT moves the cursor to the start of the next word, while SKIP LEFT moves the cursor to the start of the previous word.

Notes

These keys provide a quick way to move around text.

12.8 Error Messages

EDIT displays error messages on the last line. They are as follows:

beep

You have typed an illegal answer to a prompt, or used a command when it is not valid, such as deleting when in BROWSE mode, or typed an unrecognised command, such as Ctrl B.

Browse mode only

You have attempted to edit a file after loading it with the browse option (**/BROWSE**). If you want to edit it, EXIT, then repeat the EDIT command but without the **/BROWSE** option.

Copy invalid: cursor within block

You have tried to copy a block into itself. Move the cursor outside the block and try again.

Disk full... file truncated

There was not enough room to fit the whole file on the specified disk, so only part of it has been written. If you want to save the whole file, either use another disk, or delete some files first (using DELETE FILE).

Disk read failed

EDIT could not read the disk; it may be corrupt or not ready.

Disk read incomplete- file too big

There is insufficient room in memory to load the entire specified file, so as much as would fit into memory has been loaded. You may now edit this part of the file as long as your edits do not increase its size, but when you SAVE it, specify a new filename or you will overwrite the original file, losing that part which did not load. (To load the entire file, try increasing the free DOS memory, for example by reducing the BUFFERS or FILES parameters in CONFIG.SYS and rebooting.)

Disk write failed

EDIT could not write to the disk. For example, there may already be a write-protected file with the specified name, or the drive may not be ready. Press Esc to abort the command and continue using EDIT.

File not found

EDIT could not find the file specified in the EDIT command. EXIT, then check your typing. Remember that the filename must come before any options.

Filename contains invalid chars

Self-explanatory. Refer to your MS-DOS manual for full details of file names.

Invalid directory path

Self-explanatory. Refer to your MS-DOS manual for full details of path names.

Invalid filename

Self-explanatory. Refer to your MS-DOS manual for full details of file names.

Invalid option

You have included an option in an EDIT command which is not one of those specified in section 12.4. Remember that options come after the filename and must be separated by / characters.

Move invalid: cursor within block

You have tried to move a block into itself. Move the cursor outside the block and try again.

No block marked... press any key

You have tried to use a block command (BLOCK COPY, MOVE, DELETE or WRITE) but have not defined the block. Press any key to continue. Use BLOCK START and BLOCK END to define the block.

No files found

You have specified a pathname in the DIRECTORY command that does not match any files.

Replace failed...

EDIT could not find the specified text in the file, or there was insufficient room in memory to make the replacement. Remember that searching starts at the cursor position and the specified text must match exactly. If you think the problem may be with capitalisation, use the case-ignore option (SET command).

Search failed...

EDIT could not find the specified text in the file. Remember that searching starts at the cursor position and the specified text must match exactly. If you think the problem may be with capitalisation, use the case-ignore option (SET command).

Searching...

This is not an error message; it simply indicates that EDIT is searching for the specified text.

Short of memory- save file NOW!

There is no room in memory for any more text. If you can, make more room by deleting some text. If you wish to add more text, you must split the file in two (using BLOCK WRITE), then load and edit each half separately. If this is not possible, you must save the file (SAVE command), increase the free DOS memory (for example by reducing the BUFFERS or FILES parameters in CONFIG.SYS and rebooting).

Chapter 13 Introduction to Communications

This chapter provides an introduction to communications and serial interfacing, and practical information on selecting the protocol, handshaking, cabling and other aspects of setting up the serial ports.

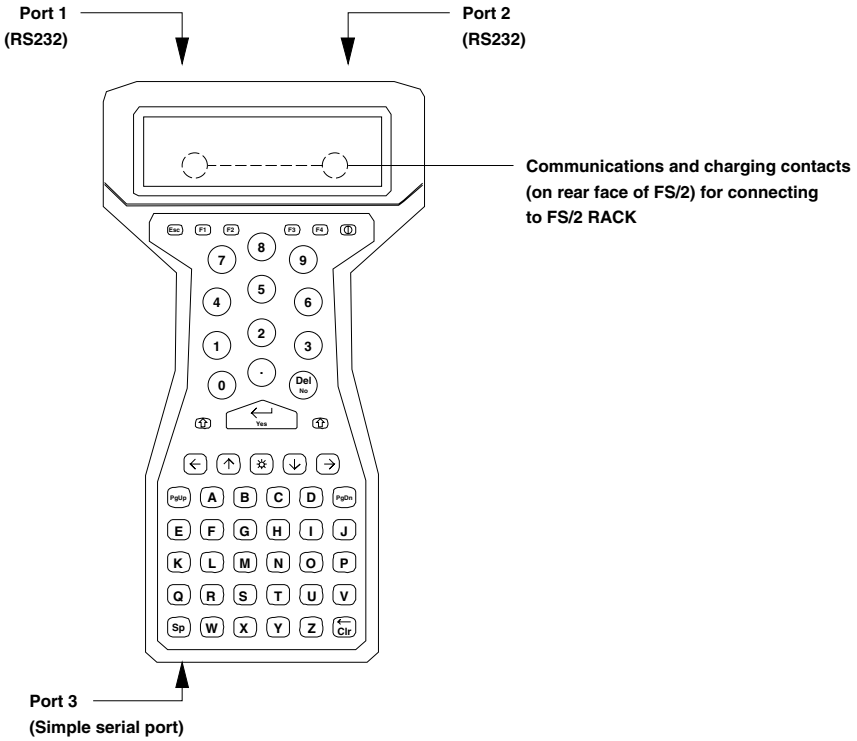
For information on using communications, see Chapter 14. For details of programming with communications, see Part 3. For more details of the communications options available, see Chapter 15 and your supplier.

13.1 Introduction

Communications facilities are especially important for portable computers, because they often rely on communications to exchange information or programs with remote computer systems.

The **FS/2** is unusual in providing extremely flexible and powerful communications as standard. This allows you to communicate with most other types of computer, peripherals, modems and other devices.

The **FS/2** has two industry-standard RS232/V24 serial communications ports as standard, plus a simpler extra serial port. It may also be fitted with a **Communications Via Charging** option to allow serial communications via charging contacts, or with an integral modem for communications via telephone lines:



Port 1 is normally used by MS-DOS and applications as the COM1 device, while Port 2 is normally used as the COM2 device. However, if the **Communications Via Charging** option is fitted, COM1 can also be routed through the charging contacts for communication via the **FS/2 Communications and Charging Rack**, as described in Part 3. If the modem option is fitted, COM1 can also be routed via the modem, as described in Part 3.

Port 1 and Port 2 conform in general with the RS232/V24 specification, which is used for serial interfaces in virtually every computer system, terminal, printer and modem. This allows you to 'plug in' to most other systems usually without modification, including microcomputer systems such as the IBM-PC.

The **FS/2** will normally be used as a self-contained computer, with the ports being used to connect suitable peripherals such as wands, printers or modems. However, the ports may also be used to connect to a host computer system, allowing you to use the **FS/2** as a portable terminal.

An **FS/2** can also communicate with another **FS/2** or other Husky computers, either side-by-side on the bench or over long distances by telecommunication channels.

Note: In this chapter, 'host' is used to refer to the system that is communicating with the **FS/2**. It will typically be another computer, modem or terminal.

13.2 Communications packages

The **FS/2** has been designed to closely emulate IBM PC hardware, to give you access to the range of software available for that computer. This emulation includes the serial ports and communications.

Husky Computers provide a communications package, which you can select when appropriate, that has the following major advantages:

- Support for protocols (XON/XOFF and any optional protocols installed), providing more secure data transfer.
- Configurable handshaking, to suit a wide variety of devices and connection methods.
- Faster data transfer (up to 38,400 Baud) for efficient communications.
- Data buffering for reliable fast transfer.
- Compatibility with other Husky handheld computers (such as **Husky Hunter 16**).

This chapter is mainly concerned with setting up and using these **FS/2** facilities. For more details of standard IBM PC communications, refer to the *MS-DOS Programmer's Manual* and *MS-DOS User's Reference*.

The **FS/2** is provided with three built-in file transfer utilities: COM.COM and the more advanced packages HCOM.COM and XL.COM (an XMODEM file loader). For details, see Chapter 14. Alternatively, in many cases you will be able to use a third party communications package, providing it will operate

on IBM PC-compatible hardware. In this case, **FS/2** communications will be completely ignored; the package will use the serial ports as it would on an IBM PC.

13.3 Background information

You do not need a detailed understanding of data communications to use the powerful facilities. You simply need to know how to:

- Connect to the remote system.
- Set up the **FS/2 communications to suit the remote system.**
- Use the communications facilities provided.

The following background information may however be of interest.

13.3.1 Buffering

FS/2 communications provides data buffering via invisible 'buffers' that effectively disconnect the application program from the outside world. The communications package is driven by interrupts, for maximum efficiency. This ensures a smooth flow of data and correct handling of communications even when the **FS/2** is busy doing something quite different!

Because the communication package is interrupt driven, the execution of user programs is generally not affected by communications. However, the user program may slow down if the serial line is busy. The buffers are available whenever the machine is powered up, even if the application program is not requesting communication. Incoming messages will be received and held in the buffer, while any outgoing data remaining will continue to be sent down the line. Any protocols selected will continue to be observed.

13.3.2 Data Transmission

While using **FS/2** communications, transmitted data is initially written to a 256 character transmit buffer (one for COM1 and one for COM2). Characters are removed from this buffer by the interrupt-driven communications package as and when the remote system is ready to receive them.

If the buffer becomes full, then the application is held up until the characters are sent (or a timeout occurs).

If a timeout or other communications failure is detected, it is reported and execution of the user program is suspended until the user acknowledges the error.

13.3.3 Data Reception

While using **FS/2** communications, received data is placed initially in a 256 character wrap-round receive buffer (one for COM1 and one for COM2).

If the buffer becomes full, the protocol or handshaking which have been selected should prevent reception of further data. However, if the remote system does not stop transmitting when requested to (ie does not respond correctly to the protocol or handshaking selected), the later characters overwrite the earlier characters.

An application reads data from this receive buffer. If there is sufficient data in the buffer, then it will be returned immediately. If there is insufficient data, the **FS/2** will wait for it to arrive (or until a timeout occurs).

Reception of data is completely transparent to the application being run. Data may be sent at any time and the communications protocols will function as configured.

If a timeout or other communications failure is detected, execution of the user program will be suspended until the user acknowledges the error. (See section 14.12.)

13.4 Connecting up

The **FS/2** can be provided with a variety of different connectors, to suit different uses. The main ports (Port 1 and Port 2) can either be provided by two 12-way connectors, one 25-way D type, or two 9-way D types. You can connect or disconnect at any time: you do not need to power down first.

Note: Never try to force a mating connector home. Check that the connector is correctly aligned. If it won't fit easily, check for orientation or damage.

If you wish to make your own cables, refer to Appendix F for pinouts and section 13.7 for example cables you'll need to connect to the most popular computers and peripherals and information on complying with EMC and FCC legislation.

Remember that if you are using **FS/2** communications, the behaviour of the handshaking lines is configured by the UTIL utility (or the application you are using).

13.5 Configuring FS/2 communications

When you reboot (or turn on for the first time), the default **FS/2** communications is selected, with the following settings:

Speed	2400	Null	00	Echo	No
Protocol	None	CTS	No	TXt/o	Off
Length	8	RTS	Off	RXt/o	Off
Parity	None	DTR	No	Serig	Off
Stop	1	DSR	No		
Lf	No	DCD	No	FS2 Mode	Yes

To use IBM communications, you or the application must select it first. See section 10.7 for details of selecting IBM communications via the HOT key; see Part 3 for details of selecting IBM communications from an application.

If you are using an application written especially for the **FS/2**, it should select and configure communications automatically. In this case, you won't be required to intervene.

However, an application might present a menu for you to select from. In this case, once you've selected the mode you require, it will configure communications without further action.

If you want to use **FS/2** communications from MS-DOS or with an application that doesn't provide its own communications handling, you must configure communications first, by using the UTIL utility.

To do this, select MS-DOS command mode and type:

```
C:\UTIL ↵
```

then select the appropriate communications menu option. This displays the current configuration for the port. Use the ← and → keys to move the highlight to the options you want to alter, then use ↑ and ↓ to adjust the displayed value as required.

When you have finished, press ↵ to return to the previous menu. You can then set up the other ports, or press Esc to return to MS-DOS command mode with the **FS/2** communications package installed and configured as you have requested.

If you have installed one of the more complex optional protocols, an extra menu screen will be displayed for you to configure. Full details will be supplied with the protocol.

If you simply want to examine the configuration, press Esc without using the cursor keys.

The individual options will now be described, after a brief overview of handshaking and protocols. For details of the operation of UTIL, refer to Chapter 10.

13.5.1 Handshaking

While you do not need to know how handshaking works in order to use **FS/2** communications, you may find the following of interest.

Handshaking is a form of control provided by adding extra wires between the two communicating systems. These allow the two systems to communicate information such as 'I am ready to transmit' or 'I am ready for another character'.

Each handshaking signal is carried by a different wire and has a different name (CTS, RTS, DTR, etc). These names are often used interchangeably for the signal and for the wire or pin carrying it.

COM1 and COM2 include a number of handshaking lines which conform to the standard RS232 specification for use with modems, and may be configured to suit particular requirements.

Handshaking is usually used when operating with a modem, but may also be used when communicating with slow devices (such as printers) which are connected direct to the **FS/2**, or to allow the **FS/2** to suspend data transmissions to it.

As handshaking involves extra wires, it cannot be used over normal telephone lines, to control the remote system. Instead, handshaking is used to control the modem which connects the **FS/2** to the telephone line. (A control mechanism similar to handshaking can be achieved by using a protocol, which includes control messages with the data being transmitted. See section 13.5.2.)

You can change the way the **FS/2** produces and reacts to handshaking signals from applications or the UTIL utility. This makes communications rather easier than with systems which have fixed handshaking (with these, you often need to produce custom cables to 'trick' handshaking).

The individual handshaking lines are described in turn later in this chapter, with the single exception of Ring Indicator (RI). RI is an input which will turn the **FS/2** on. It is often used by an auto-answer modem, to turn the **FS/2** on when a call is received so it can process the call.

13.5.2 Protocols

While you do not need to understand how protocols work in order to use communications, you may find the following information of interest.

Communications protocols are standard ways of organising data for transmission, controlling transmission, detecting and handling errors.

A protocol transmits control information along the same path as used for data. Since it does not use extra wires, a protocol can be used over standard telephone lines, unlike handshaking.

Just like other configuration details, the protocols used on transmitter and receiver must be the same.

The following protocols are provided as standard, for COM1 and COM2:

- XON/XOFF
- NONE

The NONE protocol is suitable for transferring ASCII (7-bit) or binary (8-bit) data; XON/XOFF is only suitable for ASCII data.

These protocols will now be described in turn.

13.5.2.1 NONE

Reception

As its name implies, this selection does nothing to control the incoming data; transmission will normally be controlled by handshaking. The serial interface behaves like a simple Teletype. Characters are placed in the receive buffer when they are received, then removed when the application requests serial input.

If there is no room in the receive buffer, received characters will overwrite previously received characters. (This would normally be prevented by handshaking with the remote system.)

Transmission

Each character sent by the application is placed in the transmit buffer (if there is room). Characters are then removed and transmitted when the remote system is ready for them. Transmission would normally be controlled by handshaking.

If there is no room in the transmit buffer, the application will be made to wait for room.

13.5.2.2 XON/XOFF

Reception

If an incoming character causes the receive buffer to have 240 or more unread characters, the **FS/2** transmits an XOFF character (DC3, 13H or Control-S), which should prevent the host sending further characters. When there are only 100 characters left unread in the buffer, the **FS/2** sends an XON character (DC1, 11H or Control-Q), which should tell the host to carry on transmitting.

Once the **FS/2** has sent an XOFF, it continues sending them every three seconds until it is ready for more data. It then sends XONs every three seconds until it receives more data. (This helps make sure that flow is controlled correctly, even if the host misses the first XON or XOFF.)

Transmission

While transmitting, the **FS/2** continuously examines its input data line for XON or XOFF characters sent by the host.

If an XOFF or stream of XOFFs are received, the **FS/2** stops transmitting as soon as the character being transmitted is finished. It will only restart transmission when it receives an XON from the host.

By the very nature of this protocol, indeterminate handshaking situations may occur if any conditions are altered during transmission.

Note: When the host sends an XOFF, the **FS/2** may send up to two more characters, depending on data link speed. This is due to the time taken to receive the XOFF and the possibility of just missing the start of the next character.

The host does not need to send an XON at the start of transmission.

13.5.2.3 Optional Protocols

To provide the fast, high integrity communication required by most mainframe computers, the **FS/2** can be supplied with a number of advanced protocols.

For example, Husky Computers' HWK3780 is based on the IBM3780 synchronous protocol, but is asynchronous and uses the ASCII character set rather than the EBCDIC character set. This protocol includes error detection and automatic retries and binary data capability. It has been developed for trouble-free communications with other Husky computers and Husky Communications Managers, over normal telephone lines.

If you select one of these protocols by using UTIL, you must supply additional information to configure the protocol. You do this by selecting options from an extra menu screen which is displayed when you press ⏎.

Other protocols may also be available. Contact your supplier for details.

13.5.3 Port set-up options

The port set-up options will now be described, in alphabetical order. Except where noted otherwise, all options apply to both COM1 and COM2.

Note: When COM1 is redirected via the charging contacts, certain additional restrictions apply. For details, see section 13.5.4.

CTS

Use

To control the response to the CTS (Clear To Send) handshake input while transmitting.

Notes

Setting	Result
Yes	The **FS/2** will only transmit data if CTS is active (positive). CTS is tested at the start of each character. If CTS goes inactive part way through transmitting a character, that character will be completed before transmission stops.
No	CTS is ignored.

DCD

Use

To control the response to the DCD (Data Carrier Detect) handshake input on COM1 or COM2.

Notes

Setting	Result
Yes	The **FS/2** will receive data normally only while DCD is active (positive).
No	DCD is ignored.

DSR

Use

To control the response to the DSR (Data Set Ready) handshake input on COM1 or COM2, while transmitting or receiving.

Notes

The connected device (usually a modem) can use this signal to tell the **FS/2** when it is ready to operate.

Setting	Result
Yes	The **FS/2** will transmit or receive only while DSR is active (positive).
No	DSR is ignored.

DTR

Use

To control production of the DTR (Data Terminal Ready) handshake output on COM1 or COM2, while transmitting or receiving.

Notes

This signal is provided to allow you to use auto-answer modems that require DTR to be present before generating carrier.

Setting	Result
Yes	DTR goes active (positive) when the **FS/2** is ready to receive or transmit.
No	DTR remains inactive.
On	DTR permanently on.

ECHO

Use

To control whether characters will be displayed on the screen as they are transmitted.

Notes

Data transmission and reception are not affected by echoing and the displayed characters are not passed to user programs or entered in the receive buffer.

ECHO is usually used to mimic full duplex operation with a half duplex remote system. If the remote system is operating in full duplex mode, selecting ECHO will display each character twice!

Setting	Result
Yes	Characters are echoed as they are transmitted.
No	Characters are not echoed.

Echoing a non-text file is not recommended.

FS2 MODE

Use

To select IBM or **FS/2** (Husky) communications.

Notes

See section 13.3 for information on **FS/2** and IBM communications modes.

LENGTH

Use

To set the number of data bits transmitted or expected when receiving.

Notes

Setting	Result
7	Seven data bits
8	Eight data bits

Note: If transmitting binary files, set LENGTH to 8.

Note that you cannot select 5-bit or 6-bit data lengths from UTIL, although the IBM PC supports these. This is unlikely to cause problems, as these data lengths are very rarely used.

LF

Use

To control automatic transmission of a LF character (decimal 10, hexadecimal 0AH) after each CR (decimal 13, hexadecimal 0DH) when transmitting.

Notes

This option is mainly provided for use with printers or other remote systems that require an LF after a CR to start a new line.

Setting	Result
Yes	A LF will be inserted after each CR transmitted, even if there is already a LF in the text.
No	Extra LFs will not be inserted, although any LFs in the data will be transmitted as normal.

Note: When sending binary data (such as a machine code program), set LF to 'No' to avoid corrupting the data.

Also note that with LF on, you are adding characters to the transmitted data, so the length will be greater and mechanisms such as checksums will be misled.

NULL

Use

To control whether the **FS/2** inserts NULL characters (decimal 0, hexadecimal 00H) after each CR, when transmitting.

Notes

This option is mainly provided for use with printers that take a significant time to perform a Carriage Return operation and don't have handshaking or buffering. NULLs are not printed, they simply give the printer time to perform the CR function.

Setting	Result
0	No NULLs are added.
1..20	1..20 NULLs are added.

If LF is set to 'y', any NULLs will be sent after the CR LF sequence.

Note: If transmitting binary files, set NULL to 0 to avoid corrupting the data.

PARITY

Use

To select the data parity to add to transmitted data, and the data parity checking that will be used to check received data.

Notes

When transmitting, PARITY has the following significance:

Setting	Result
None	A parity bit is not added.
Odd	A parity bit of 0 or 1 is added to produce an odd number of logical 1's in the data bits.
Even	A parity bit of 0 or 1 is added to produce an even number of logical 1's in the data bits.

When receiving, PTY has the following significance:

Setting	Result
None	A parity bit is not expected. If parity bits are sent, they will produce data framing errors.
Odd	The data is checked for an odd number of logical 1's (including the parity bit). If the check succeeds, the character is returned to the calling program. If the check fails, the character is not returned and a parity error is flagged
Even	The data is checked for an even number of logical 1's (including the parity bit). If the check succeeds, the character is returned to the calling program. If the check fails then the character is not returned and a parity error is flagged

Parity errors on receive may be ignored, display a communications error message (see section 14.12), or be handled by your application (see Part 3).

Note that the **FS/2** does not support a fixed parity of 1, unlike the IBM PC. This is unlikely to cause problems as fixed parity is very rarely used.

PROTOCOL

Use

To select the protocol to use for communications.

Notes

The standard protocols available are:

NONE
XON/XOFF

Other protocols may also be available, if they have been installed. Selecting one of these more complex protocols will display an extra menu screen, which you must use to configure it. See section 13.5.2 for further details of these protocols.

RTS

Use

To control production of the RTS (Request To Send) handshake output on COM1 or COM2, while transmitting or receiving data.

Notes

The **FS/2** uses this signal either to tell a remote device that is ready to send data, or to prevent further reception when its receive buffer is full.

Setting	Result
OFF	The RTS line is permanently active (positive).
HOLD	The RTS line is normally active (positive) and only goes inactive (negative) when the receive buffer is full. This allows the **FS/2** to hold up a transmitting device (by lowering the RTS line) until it has removed enough characters from the receive buffer to allow the transmitting device to send more data (by raising the RTS line again). This mode can be used when communicating with another Husky computer, via a crossed cable. Normally, RTS would be connected to the transmitting device's CTS input.
TRUE	This mode is mainly used with a half duplex modem or similar device, when sending data in blocks and relying on the protocol for flow control. When the **FS/2** is ready to transmit data, it raises RTS to active (positive), then waits for a reply on the CTS line (if enabled) before sending the data in the transmit buffer. RTS remains active until all the data has been sent and the buffer is empty, then the **FS/2** returns RTS to the inactive state (negative).

RX T/O

Use

To set the timeout period for data reception.

Notes

The timeout is initiated by a request for serial input by an application. If a character is not read from the receive buffer within the specified time limit (because it is empty), a communications error will result.

Reception of any character, or noise, will reset the timeout.

Note that if no attempt is made to read the input communications buffer, this timeout will not occur.

Setting	Result
Off 1..60	No timeout Timeout after 1 to 60 seconds

Note: If an optional protocol is being used which has its own timeouts, disable the timeout.

SERIG

Use

To filter a particular character from received data.

Notes

This tells the **FS/2** to remove a particular ASCII character from serial input ie to receive it normally but not place it in the receive buffer, so the character is never passed to the application.

This option is provided for use with computer systems that transmit abundant spurious characters (such as NULL, LF, XON or DEL) along with the real data. To save the application having to filter these unwanted characters, use SERIG.

Setting	Result
0-127 Off	Filter the specified ASCII code from received data. Do not filter any characters.

To set SERIG to ‘Off’, increment past 127 or decrement past 0.

Note: Do not use SERIG with binary data or protocols other than NONE or XON/XOFF.

SPEED

Use

To set the transmit and receive Baud rates (speeds) to suit the connected device.

Notes

The available Baud rates are:

110	1200	9600
150	2400	19200
300	4800	38400
600		

Note that external devices, the communications channel, or the application may not be able to handle the highest Baud rates.

STOP

Use

To set the number of stop bits transmitted.

Notes

Setting	Result
2 1	2 stop bits 1 stop bit

TX T/O

Use

To set the timeout period for data transmission.

Notes

The timeout is initiated by a request for serial output by an application. If the application fails to put a character in the transmit buffer (because it is full) within the specified time limit, a communications error will occur.

If no attempt is made to transmit data, this timeout will not occur.

Setting	Result
Off 1..60	No timeout Timeout after 1 to 60 seconds

Note: If an optional protocol is being used which has its own timeouts, disable the TX timeout.

13.5.4 Communications via charging contacts

For information, refer to the *FS/2 Communications and Charging Rack System Developer's Guide*.

13.6 Configuring IBM communications

Standard IBM communications will be selected by any standard application or command that initialises communications. The default configuration is as follows, for COM1 and COM2:

Speed:	2400
Data bits:	8
Parity:	No
Stop bits:	1
Retry on timeout:	No

(All handshake lines are inactive and interrupts are disabled.)

You can alter all these settings from MS-DOS command mode, by using the standard MS-DOS MODE utility. For example, to select 4800 Baud, 8 data bits, odd parity, 1 stop bit and no timeout for COM2, type:

```
MODE COM2 48,O,8,1,P ↵
```

Note that the following IBM PC-compatible settings are not supported:

Data bits:	5, 6 (on COM2)
Parity:	1 (fixed)
Stop bits:	1.5

These limitations are unlikely to affect you in practice, as these settings are very rarely used.

Note: For details of the MODE utility refer to the *MS-DOS User's Reference.*

13.7 Example communications set-up

This section describes the cables and configurations you will need to connect the main serial ports, PORT 1 (COM1) or PORT 2 (COM2) to a number of popular devices, in order to transfer binary or ASCII (text) data. The cable details assume that the unit is fitted with 12-way connectors.

Note: To comply with EMC and FCC legislation, all cables must be shielded, with grounded metal connector shells.

13.7.1 Communicating with another FS/2

13.7.1.1 Cable

To connect Port 1 or Port 2 on one **FS/2** direct to Port 1 or Port 2 on another, you need a simple 'crossed cable'. For example, assuming they both use 12-way connectors:

First **FS/2** (12-way male)		Second **FS/2** (12-way male)
B	----------	C
C	----------	B
D	----------	E
E	----------	D
G	----------	G

13.7.1.2 Configuration

As the two computers are connected together by a short cable, you can use the fastest speed available, simple CTS/RTS handshaking and parity checking. There is no need for a protocol, as the handshaking controls data flow and parity checking provides reasonable security.

Configure each **FS/2** as follows:

Option	Setting	Comments
Baud rate:	38400	As fast as you can, to save time.
Protocol:	None	None needed.
Length:	8	Binary data.
Parity:	Even	Allows data integrity checking
Stop bits:	1	Minimum required to save time.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	Hold	Handshake output when receiving and no more room. (Connected to transmitter's CTS.)
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to receiver's RTS.)
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	No	There's no point viewing binary data!
TXt/o:	30	As there's a direct connection, you only need a short timeout, but a longer time makes operation easier.
RXt/o:	10	A fairly short timeout, as this is used to indicate the end of the received file.
Serig:	off	Filtering bytes would corrupt binary data.

13.7.2 Communicating with a Hunter 16

13.7.2.1 Cable

To connect Port 1 or Port 2 on the **FS/2** to COM1 on **Hunter 16**, you need a cable like this, assuming 12-way connectors on the **FS/2**:

FS/2 (12-way male)		Hunter 16
B	----------	3
C	----------	2
D	----------	5
E	----------	4
G	----------	7

13.7.2.2 Configuration

Configure the two computers as described in section 13.7.1.

The **Hunter 16** COM1 port is also configured by using the UTIL command.

13.7.3 Communicating with an external modem

13.7.3.1 Cable

Most modems are configured as DCEs, so you can use a cable like this to connect to the 12-way connectors:

FS/2 (12-way male)		Modem
B	----------	2
C	----------	3
D	----------	4
E	----------	5
G	----------	7

Or, if a 25-way connector is fitted to the unit, use a ‘straight’ cable (pin1--pin1, pin2--pin2, etc) to connect to COM1.

13.7.3.2 Configuration

You must configure the handshaking and data format to suit the modem, but select a protocol to suit the remote computer.

For example, to suit a typical modem, configure the **FS/2** as follows:

Option	Setting	Comments
Baud rate:	*	To suit the modem.
Protocol:	*	To suit the remote system.
Length:	8	Binary data.
Parity:	*	To suit the modem.
Stop bits:	*	To suit the modem.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	True	Handshake output when the **FS/2** wants to start transmission. (Modem replies on CTS.)
DTR:	Yes	May be needed to turn on modem.
CTS:	Yes	Handshake input from modem, when the **FS/2** asks to start transmitting (by raising RTS).
DSR:	Yes	Input to indicate that modem is ready to operate.
DCD:	Yes	Input to indicate received data is valid.
Echo:	No	There's no point viewing binary data.
TXt/o:	30	To help detect any problem between the **FS/2** and the modem.
RXt/o:	30	To help detect any problem between the **FS/2** and the modem.
Serig:	off	Filtering bytes would corrupt binary data.

Configure the modem interface speed, parity, data and stop bits as the **FS/2**. Configure the modem line speed to suit the remote modem.

13.7.4 Communicating with an IBM personal computer

13.7.4.1 Cable (25-way)

Most IBM PCs and compatibles usually have a 25-way connector fitted, usually female but sometimes male. If a 25-way connector is fitted, you will require a cable wired as shown below.

If a 9-way connector is fitted, you will require a cable wired as shown in the next section.

FS/2		IBM PC
(12-way male)		(25-way female or male)
B	----------	3
C	----------	2
D	----------	6
E	----------	4
F	----------	5
F	----------	20
G	----------	7

Note that pins 5 and 20 in the IBM end of the cable are both connected to pin F in the **FS/2** end. This will typically be achieved by linking them at the IBM end of the cable.

13.7.4.2 Cable (9-way)

IBM PC-ATs, PS/2s and compatibles may also be fitted with 9-way sockets, in which case you will require a cable like this:

FS/2		IBM PC-AT
(12-way male)		(9-way female or male)
B	----------	2
C	----------	3
D	----------	6
E	----------	7
F	----------	8
F	----------	4
G	----------	5

Note that pins 4 and 8 in the IBM end of the cable are both connected to pin F in the **FS/2** end. This will typically be achieved by linking them at the IBM end of the cable.

13.7.4.3 Configuration

Configure the **FS/2** as follows:

Option	Setting	Comments
Baud rate:	9600	As fast as the IBM can go.
Protocol:	None	None needed.
Length:	8	Binary data.
Parity:	Even	Allows data integrity checking.
Stop bits:	1	Minimum required to save time.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	Hold	Handshake output when receiving and no more room. (Connected to transmitter's DSR.)
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to receiver's RTS.)
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	No	There's not much point in viewing binary data.
TXt/o:	0	Not needed, but could set to 30.
RXt/o:	0	Not needed, but could set to 30.
Serig:	off	Filtering bytes would corrupt binary data.

Configure the IBM as follows:

Option	Setting
Speed:	9600
Data bits:	8
Parity:	E
Stop bits:	1
Retry on timeout:	No

13.7.5 Communicating with a serial printer

13.7.5.1 Cable

To connect to a serial printer, you'll need a simple 'crossed cable':

FS/2		Printer
B	----------	3
C	----------	2
D	----------	5
E	----------	4
G	----------	7

Printers usually don't transmit data back to the computer (unless using the XON/XOFF protocol), so you may not need to connect the printer's TXD and CTS pins (pin 2 and pin 5). If you are willing to use a slow Baud rate, you may even be able to dispense with all handshaking and use the following 2-wire cable:

FS/2		Printer
B	----------	3
G	----------	7

If you do this, you must also turn CTS handshaking off on the **FS/2** (ie set the CTS option to No, using UTIL).

13.7.5.2 Configuration

As the printer is connected by a short cable, you can use the fastest speed available and simple CTS/RTS handshaking.

To show some of the versatility provided by configurable communications, assume that the printer does not have a buffer, perform a LF automatically when it receives a CR character, or handshake properly, but does support the XON/XOFF protocol.

Configure the **FS/2** as follows:

Option	Setting	Comments
Baud rate:	*	Set to suit printer. (As fast as you can, to save time.)
Protocol:	XON/XOFF	Used to supplement handshaking.
Length:	7	ASCII data.
Parity:	*	Set to suit printer.
Stop bits:	*	Set to suit printer
LF:	Yes	Adding LFs after CRs to make the printer advance the paper correctly.
Null:	20	Needed to give printer time to perform CR LF.
RTS:	-	Irrelevant.
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to printer's RTS.)
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	Yes	To monitor progress.
TXt/o:	10	This timeout will allow you to monitor problems such as paper out or off-line.
RXt/o:	-	Irrelevant as printers don't usually transmit data!
Serig:	Off	Irrelevant.

Configure the printer as follows:

Set the baud rate, parity, data bits and speed as set on the **FS/2**, and select XON/XOFF protocol.

(Or, if you want to use the simple 2-wire cable, set CTS to 'No' and select a Baud rate which is significantly slower than the printer's printing speed. For example, if the printer prints at 40cps, select a speed of 300 Baud or less. You may need to link the printer's CTS to an active pin.)

Chapter 14 Using Communications

This chapter describes how to use communications facilities, once you have set them up and connected to the other device, as described in Chapter 13.

CAUTION: Connect only approved cables and peripherals to the FS/2.

14.1 Introduction

The **FS/2** communications ports can be used to connect to a very wide range of devices. These fall into two main categories: other computers and computer peripherals.

Communications provide a quick and easy way to load programs and data onto the **FS/2**, and return collected data to other systems for processing.

14.2 Selecting the communications package

As already described, the **FS/2** provides two communications packages:

- Simple IBM-compatible communications
- Sophisticated Husky (**FS/2**) communications

When you reboot, Husky (**FS/2**) communications will be selected. This provides a number of advantages over IBM-compatible communications (see section 13.2). If IBM communications has been selected but you want these advantages, select and configure **FS/2** communications by using the UTIL utility as described earlier in this manual, and simple utilities (such as COPY) and any MS-DOS applications that do not re-initialise communications will use it automatically.

If you find that an application re-initialises communications, no harm will have been done; that application will simply use IBM communications.

Applications written specifically for the **FS/2** may also select, configure and use **FS/2** communications automatically.

Remember that communications on the **FS/2** is **software controlled**, so if **FS/2** fails to communicate, always check that the port is configured correctly.

14.3 Starting communication

When you turn the **FS/2** on, the serial interface is left turned off to conserve power. When a user program attempts to send or receive data, the **FS/2** turns its interface on automatically and waits approximately 2 seconds to allow it to settle down before beginning transmission or reception.

While the port is turning on it may send spurious characters to the remote system, which could cause problems. To avoid this you can turn the port on immediately before connecting to the remote system. For example, by typing the following in MS-DOS command mode:

```
COPY CON COM1 ↵
↵
Ctrl Z ↵
```

The port remains turned on until you turn the **FS/2** off, so further transmissions are not affected in this way. If you are not going to use communications for a while, turn off again to save battery power. (The application may turn off the port automatically, as described in Part 3.)

14.4 Using standard facilities

The serial ports can be used from standard applications, as COM1 and COM2. As LPT1 is also defined as COM1, printed output will also normally be routed to COM1.

As supplied, communications can also be used in MS-DOS commands, by using the appropriate device name in place of a filename.

The main workhorse for MS-DOS file transfer is the COPY command. For example:

```
COPY COM1/A INPUT.TXT ↵
```

would store input received from COM1 in the file INPUT.TXT, until an end-of-file marker (Ctrl Z) is received. Note the **/A** switch; this makes sure that Ctrl Z is interpreted as end of file.

CAUTION: **There is a problem when using the MS-DOS COPY command like this. If the transmitting system sends data slower than the receiving system requires it, the COPY command will time out, inserting a NUL (ASCII 0) character in the input for each such timeout. This is unlikely to happen if the transmitting system is simply copying data from a fast disk (such as the FS/2 RAM disk), but may cause problems if copying data from a slow peripheral or processing data before sending it. If this is the case, try a slower Baud rate or edit the NULs from the received file.**

COPY LISTING.TXT COM2/A ↵

would transmit the file LISTING.TXT via COM2, ending with a Ctrl Z (so the other system can detect the end of the file). Again, note the **/A** switch, which ensures that Ctrl Z is sent. If the destination does not need to detect the end of the file (for example, is a printer), you could omit this.

These commands may be quite sufficient for transferring ASCII (text) files, but are not suitable for transferring binary files. To do this, you must use the **FS/2** HCOM or COM utilities (see sections 14.6 and 14.5) or a communications application (see section 14.10).

COM1 is configured as LPT1 automatically, so any command that prints will usually direct its output to COM1. For example:

Prtsc	- output screen contents to COM1
Ctrl P	- toggle screen output to COM1 too
PRINT *filename* ↵	- queue a file for output to COM1 in background. (The PRINT command is not installed as standard.)

Standard input and output can also be redirected to the ports in the usual way. For example:

DIR >COM2 ↵	- catalogue current directory and send result to COM2

SORT <COM1 >INDEX ↵ - input text from COM1, sort it and store the result in the file INDEX. (The SORT command is not installed as standard.)

14.5 Using the COM utility

COM is a simple file transfer utility built into the **FS/2** which makes it easy to exchange files with another computer via the serial ports. It provides binary transfer and two types of ASCII transfer, for compatibility. For more sophisticated facilities, use the HCOM (see section 14.6) or XL (see section 14.7) utility.

14.5.1 Setting up

Use the UTIL utility to configure the speed, word length, parity and stop bit settings to suit the other computer. For maximum reliability, select FS2 mode, set CTS to Yes and RTS to Hold.

14.5.2 Command options

The COM command takes the following form:

COM *[path]filename [switches]*

The switches are:

- **/R** Receive a file and store it as *[path]filename*.
- **/S** Send the file *[path]filename*.
- **/A** Only valid with **/S**, this specifies ASCII transfer with transmission ending at the first Control-Z (1AH) character. (This is the default mode if not specified.)
- **/Z** Only valid with **/S**, this specifies ASCII transfer with transmission ending after the first Control-Z (1AH) character has been sent.
- **/B** Only valid with **/S**, this specifies binary transfer. Transmission ends when the number of bytes specified by the file's directory entry have been sent.
- **/1** Use COM1.
- **/2** Use COM2.

If you do not supply any switches, **/R/1** is assumed. If you use **/S** without any other switches, **/A** is assumed.

14.5.3 Sending a file

If you know that a file might contain Control-Z characters, use the **/B** switch to specify binary transfer.

If you are sending a text file, you can still use **/B**, but should use **/A** or **/Z** if the file has been created by an application which uses Control-Z for end of file (such as EDLIN) and then pads the file to some other length (eg a whole number of blocks). To decide whether to use **/Z** or **/A**, read the description of the COPY command in the MS-DOS Manual.

While COM is transmitting it will display **Transmitting,** and then **Complete** when it has finished. If you see any other messages, see section 14.5.6.

14.5.4 Receiving a file

When you use COM to receive a file, it will display **Waiting** and then **Loading** while receiving data. Press Ctrl C at any time to terminate the transfer; COM will display **Aborted** and finish writing the received file to disk. If you see any other messages, see section 14.5.6.

14.5.5 Examples

To send the text file FILES.LST complete with Control-Z, via COM1:

```
COM FILES.LST/S/Z ↵
```

To send the program file PROG2.EXE from the C:\UTILS directory, via COM2:

```
COM C:\UTILS\PROG2.EXE/2/S ↵
```

To receive data from COM2 and store it in C:\BACKUP\PROG.COM:

```
COM C:\BACKUP\PROG.COM/R/2
```

14.5.6 Error messages

The following error messages may be displayed by the COM utility:

`Unable to open file`
You have specified a file to send which does not exist.

`Unable to create file`
You have specified a file to receive which is not a valid DOS file name, or there is already a file with this name which is write-protected.

`Invalid file name`
You have not specified a file name, or the file name is not a valid DOS file name.

`Error writing to file`
COM could not write received data to the disk. The most likely reason is a lack of disk space.

`File read error`
COM could not read the some or all of the information from the file that you specified to send. (Use CHKDSK to check the file.)

`Communications error`
Either the communications settings on the two computers do not match, or the cable is faulty.

`Receive options not allowed`
You have typed the **`/A`**, **`/B`** or **`/Z`** option with **`/R`**. These options can only be used with **`/S`**.

`Conflicting or too many options`
You have typed two conflicting options, such as **`/S`** and **`/R`** or **`/1`** and **`/2`**.

`Unknown option`
You have typed an option which is not one of **`/1`**, **`/2`**, **`/A`**, **`/B`**, **`/R`**, **`/S`** and **`/Z`**.

14.6 Using the Husky File Transfer Utility, HCOM

HCOM is a versatile file transfer utility, designed to make transferring files between a PC and the **FS/2** quick and easy. The software is in two parts: the **FS/2** part is built into the **FS/2**, while the PC part is supplied on diskette.

You control HCOM from the PC keyboard and can view directories on both the PC and the **FS/2**, and copy single files or groups of files in either direction.

HCOM is described in detail in a separate document, the *Husky File Transfer Utility Guide*, with extra information in a README file on the HCOM diskette.

For the additional information you will require when the **FS/2** is connected to the PC via the **FS/2 Communications and Charging Rack** (**Rack**), refer to the *Husky FS/2 Communications and Charging System Developer's Guide*.

14.7 Using the Husky XMODEM Loader, XL

XL is a file transfer utility which allows you to download a program file from a host using the XMODEM protocol and then execute it on the **FS/2** automatically. This will typically be used to update the user's application automatically. By using the **Rack**, you can download a program to up to 10 **FS/2** units at a time.

XL is built into the **FS/2** ROM. To use it you will also need a third party program on the host which uses the XMODEM protocol.

14.7.1 Using XL via Port 1

If you are connecting via Port 1:

- Turn on the **FS/2**.
- At the DOS prompt, type the XL command:

  XL [*filename*] [*/Rmm*] [*/Pnn*] ↵

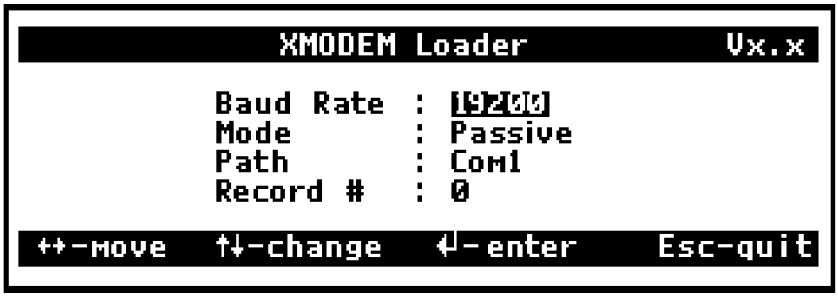
  Where:

  filename specifies the name to use for the received program. If omitted, COMMS.EXE is assumed.

  /Rmm sets the delay between reporting an XMODEM error and restarting the download to ***mm*** seconds (0..60). If omitted, 10 seconds is assumed.

  /Pnn sets the time between initial startup polls to ***nn*** seconds (0..60). If omitted, 10 seconds is assumed.

- If you have specified an invalid filename, **INVALID FILENAME** will be displayed. Press Esc to return to DOS and retype the command.
- If you have specified a filename which exists already, it will be overwritten without warning.
- The display looks like this:



  Note that the bottom line is also used to display status and error messages.

- This screen allows you to configure two options: select an option by pressing ← or → to highlight it, then press ↑ or ↓ to alter it. The options are:
  - **Baud Rate**: select the Baud rate for the transfer. You should normally select the highest rate unless you experience problems.
  - **Mode**: set this to **Active** to enable transmission of the standard XMODEM protocol characters.
- The other two fields are:
  - **Path**: this will be **COM1** unless connected via the **Rack**, in which case it should read **Cradle**.
  - **Record #**: this will be blank until transfer begins.
- When the options are set correctly, press ↵ to start the transfer.
- Initially, the status line will read **POLLING**.
- When the host starts sending data, the status line will read **LOADING** and the **Record #** field will increment as each record is received.

- When transfer has finished, **COMPLETED - SAVING** should be displayed briefly, then the received program will be executed.

If any error messages are displayed, see section 14.7.4.

To cancel the transfer at any time, press Esc. The data which is currently being received will be discarded and you will be returned to the DOS prompt.

14.7.2 Using XL via the Rack

If you are connecting via the **Rack**, also refer to the *Husky FS/2 Communications and Charging System Developer's Guide*.

14.7.3 Technical information

The XMODEM protocol is a block-oriented error-checking protocol in the public domain, which uses checksums or, optionally, CRCs for error-checking. It can be used for text or binary files and is widely supported. XL uses standard XMODEM with checksums.

XL checks for the presence of the **Rack** on startup and uses it if found, otherwise using COM1.

When the user initiates communications (press ↵) on the Active **FS/2**, it sends a POLL to the host, then waits for a configurable period (/Pnn parameter, default 10 seconds) before sending another POLL. If there is no response to 5 POLLs, the download will fail with an error message (see section 14.7.3).

XL uses checksums to check received blocks. If a received block is corrupted, XMODEM will request it 5 more times (by sending a NAK) before reporting an error to XL (see section 14.7.3).

14.7.4 XL error messages

The following error messages may be displayed while using the XL utility:

Communications Errors:

Communications Timeout Error
The connection has probably failed or has never been made. Check whether the host has hung up (modem) or cable has become disconnected (direct connection). Check that the host is on-line.

Operator Aborted
You have pressed Esc to cancel downloading.

Packet Sequence Error
A block has been received out of sequence, eg due to bad line noise. Check the line (modem) or cable (direct connection).

Xmodem Checksum Error
A corrupted block has been received five times. Check the line (modem) or cable (direct connection).

Xmodem Header Error
Check the line (modem) or cable (direct connection).

Xmodem Startup Error
Check the line (modem) or cable (direct connection).

After any of these errors, XL will discard any data received. An Active **FS/2** will restart the download after a configurable delay (/Rnn parameter, default 10 seconds), unless the user presses Esc first, which returns to DOS. A Passive **FS/2** will display the message until the operator presses Esc; it will not restart the download.

Other errors:

Disk Full
There is not sufficient disk space to store the received file. Press Esc to return to DOS and make enough space (by deleting files) or select a different drive with enough space, then run XL again.

Invalid Filename
You have specified a filename in the XL command which is not a valid DOS filename. Press Esc to return to DOS and type the command again.

14.8 Using FS/2 applications

If an application has been written especially for the **FS/2**, it should handle communications automatically, selecting and configuring communications to suit the remote system, turning the port on and off as required, and trapping any errors for you.

14.9 Using MS-DOS applications

The serial ports are configured as COM1 and COM2 so any application that allows you to use these devices can use communications. COM1 is also configured as LPT1, the device normally used for printer output, so printing will normally be routed to COM1.

If you are using a standard MS-DOS application, it probably won't provide any specialised communications facilities. In this case, you will probably only be able to output data while using it, by using the application's 'printing' options. This will normally be output via COM1, as described earlier. While you could use this to print results on a suitable printer, there's nothing to stop you connecting COM1 to another computer system which requires the information.

By default, when you reboot, **FS/2** communications will be installed. To use IBM communications simply select it before running the application (eg by using UTIL).

If you need to input files, or output files in formats not supported by the application's print option, you can use the standard MS-DOS facilities described in section 14.4.

14.10 Using MS-DOS communications packages

A number of third party communications packages are available for the IBM PC and compatibles. These typically offer very high data rates via direct connections (cables) and convenient menu-driven interface and automatic operation, including error-handling.

Some of these packages are appropriate to use with the **FS/2**, but because they are written for standard IBM PC hardware, they will not use any of the

special facilities provided by **FS/2** communications. They also may not work reliably at speeds greater than 19,200 Baud. If you are at all unsure whether a package will work, ask your supplier.

14.11 Example file transfer

The **FS/2** uses the industry-standard RS232 interface and supports the common XON-XOFF protocol and a wide range of baud rates and data formats, so it can communicate with a wide range of computers, including microcomputer systems such as the IBM PC. Optional protocols and internal upgrades extend this range even further.

This section describes how to exchange binary and text files with another system that supports 8-bit communication.

If the other system does not support 8-bit communications, to transfer binary data you must use a communications application.

14.11.1 Exchanging files with another FS/2 or Hunter 16

There are many commercially available software packages for communications between IBM-compatible computers, but this description assumes that you are using the COM utility which is supplied as standard on both the **FS/2** and **Hunter 16**. You may prefer to use the more sophisticated HCOM utility (see section 14.6).

14.11.1.1 Setting up

Set up and connect the two systems as described in section 13.7.1 (the **FS/2**) and 13.7.2 (**Hunter 16**).

14.11.1.2 Transferring files

On the transmitting system (ie the one which is sending files), select MS-DOS command mode and type:

COM *filename* /S/A ⏎ to transfer a text file, OR

COM *filename* /S/B ⏎ to transfer a binary file.

On the receiving system, select MS-DOS command mode and type:

COM *filename* /R ↵

When transfer has finished, the sender's screen should display **Completed**. Press Ctrl C on the receiving system.

If error messages are displayed on either screen, see section 14.12.

Note: See the warning about timeouts in section 14.4.

14.11.2 Exchanging files with an IBM PC

This section describes how to use the COM utility which is built into the **FS/2**. You may prefer to use the more sophisticated HCOM utility (see section 14.6)

14.11.2.1 Setting up

Set up and connect the two systems as described in section 13.7.4.

14.11.2.2 Loading files

To load a text or binary (program) file onto the **FS/2**, select MS-DOS command mode on the **FS/2** and type:

COM *filename* /R ↵

On the PC, type:

COPY *filename* COM1 ↵

When the PC has finished copying the file, it will display a message like **1 file(s) copied**. Wait a few seconds, then type Ctrl C on the **FS/2** keyboard.

If error messages are displayed on the **FS/2** screen, see section 14.12. If error messages are displayed on the PC screen, see your MS-DOS manuals.

14.11.2.3 Sending files

To send a text file to the PC, select MS-DOS command mode on the **FS/2** and type:

COM *filename* /S/A ↵

On the PC, type:

COPY COM1/A *filename* ↵

When the **FS/2** has finished sending the file it will display **`Completed.`** When the PC has finished receiving the file it will display a message like **`1 file(s) copied`**.

To send a binary file to the PC, select MS-DOS command mode on the **FS/2** and type:

`COM filename /S/B` ⏎

To receive the file, you will need to use a communications package that interprets a timeout as end of file; the COPY command does not.

If error messages are displayed on the **FS/2** screen, see section 14.12. If error messages are displayed on the PC screen, see your MS-DOS manuals.

Note: See the warning about timeouts in section 14.4.

14.11.3 Exchanging files via the FS/2 Communications and Charging Rack

The **FS/2 Communications and Charging Rack** and **Communications Via Charging** options provides quick and easy connections for charging and communications with a desktop PC. For details, see the *Husky FS/2 Communications and Charging Rack System Developer's Guide*.

14.12 Troubleshooting

If you are using one of the Husky file transfer utilities (COM, HCOM or XL), refer to its documentation for a description of its error messages.

If you cannot get communications to start:

- Check that the port is configured correctly to suit the cable and host.
- Check the cable and any intervening devices (such as modems, telephone lines, optoisolators or line buffers).
- Check that the host is ready to communicate.
- If possible, swap components (modems, cables, telephone lines) to help trace the problem.

If communications works but data is corrupted:

- Check that the **FS/2** and host are using the same data formats and speeds.
- Check that all connections are noise-free.
- Try a slower speed or more secure protocol if one is available.

If communications fails after operating correctly for a time:

- Check for noisy lines (or use a slower speed or more secure protocol).
- Check that the connection is still made (eg check that the telephone line has not been lost or a cable has not come unplugged).
- Check for component failure.

If communications fails because of timeouts, you can increase the periods or disable the timeouts entirely by using the UTIL command or by using similar options in an **FS/2** application.

If communicating via the Rack, refer to the *Husky FS/2 Communications and Charging Rack System Developer's Guide* for guidance on rules and limitations.

Chapter 15 Accessories

This chapter briefly describes the main accessories developed by Husky Computers for use with the **FS/2**. For more details, consult the products' user guides or approach your local distributor or Husky Computers.

CAUTION: Connect only approved cables and peripherals to the FS/2.

15.1 Introduction

The **FS/2** uses an operating system, protocols and communications interface that are compatible as far as practicable with the main industry standards. This makes it easy for you to extend its capabilities, by adding a variety of standard peripheral devices.

Husky Computers have also developed a range of their own peripherals and software enhancements for the **FS/2**, such as a communications and charging rack, and extra communications protocols. These are described in the remainder of this chapter.

15.2 Power

The **FS/2** can be powered by an AC adaptor, rechargeable or non-rechargeable batteries:

AC adaptors:	A wide range is available to suit differing national requirements.
Rechargeable batteries:	1.2V Nickel-Cadmium A-size. Three are required for operation.
Non-rechargeable batteries:	1.5V Alkaline-Managanese AA size, such as Duracell or Mallory MN1500. Three are required for operation.

The special **FS/2 AC adaptors** are the only units which may be used to recharge the NiCad batteries while they are installed in the **FS/2**. The use of an non Husky-approved AC adaptor or battery eliminator may damage the **FS/2** or the batteries and may contravene EMC and safety legislation.

For convenient charging of multiple **FS/2** units, use the **FS/2 Communications and Charging Rack** (see section 15.5).

15.3 Extra Memory

The **FS/2** can be supplied in a number of memory sizes. Its memory can also be extended by adding modules internally.

15.3.1 RAM

RAM modules are available to expand the main (DOS) memory and RAM disk. Memory is partitioned by using the UTIL utility.

Memory modules are fitted internally. The unit must be returned to Husky Computers or your supplier for fitting.

15.3.2 FLASH EPROM

FLASH EPROM is a device that provides non-volatile storage just like an EPROM, but which can be re-programmed while housed inside the unit, using a utility (FLASHBAK) available from Husky Computers. It is configured as drive D and used as a read-only drive. For information on using FLASHBAK, ask for Husky Application Note APN 1015.

FLASH EPROM is fitted internally. The unit must be returned to Husky Computers or your supplier for fitting. For more details, contact Husky Computers or your supplier.

15.4 Software Upgrades

When revised versions of the **FS/2** BIOS and utilities are released, you may be able to upgrade your existing **FS/2** units with them, by using the FLSHBIOS utility. However, versions which require revised hardware may not be available in this manner. For details, contact Husky Computers or your supplier.

The FLSHBIOS utility is described in Husky Application Note APN 1012.

15.5 Communications and Charging Rack

The **FS/2 Communications and Charging Rack** is an expandable modular system which provides easy drop-in connection of **FS/2** units for

communications and charging. To use the rack for communications, the **FS/2** units must be fitted with the **Communications Via Charging** option. For details, contact your supplier.

15.6 Communications

The communications capabilities of the **FS/2** can be extended by adding protocols and interfaces. For details, contact your supplier.

15.7 Optical Readers

A wide range of bar code wands and scanners can be connected to Port 1 or Port 2. For information on programming **FS/2** to use such devices, ask Husky Computers or your supplier for the *FS/2 Barcode Software Application Note*, Husky Application Note APN 1016.

15.8 Probes and Other Reading Devices

A range of probes and reading devices may be attached, such as meter reading probes. Contact Husky Computers or your supplier for details.

HUSKY FS/2

Part 3
Technical Reference

Chapter 16 Introduction

This part of the guide describes how to select, install, adapt or write applications for **FS/2**. It also provides background information which may be of interest if you wish to use non-standard peripherals.

16.1 Using this part of the guide

The information provided in this part of the *FS/2 System Developer's Guide* is of three main types:

Chapters 16 to 18	General guidelines on installing, adapting and developing applications for **FS/2**, including a system overview, compatibility issues, programming tools, etc.
Chapters 19 to 30	Summary technical information, describing the **FS/2** BIOS, memory map and software interrupts, with particular emphasis on those aspects that are not industry-standard (ie extensions and restrictions). This information is mainly intended for readers with extensive experience of programming in an IBM PC-DOS or MS-DOS environment.
Chapters 31 to 32	A description of the **FS/2** hardware, with particular emphasis on the power management and handling system.

16.2 Assumptions

This part of the guide is not a tutorial in computer programming or hardware. Nor is it intended to describe standard MS-DOS and the IBM PC hardware environment.

You are assumed to have a working knowledge of:

- 8086 assembler
- Standard MS-DOS interrupts
- Standard IBM PC BIOS interrupts

- IBM PC hardware environment

If you don't, you will need to refer to the *MS-DOS Programmer's Manual* and other standard texts on IBM compatibles and 8086 assembler.

16.3 Conventions

The same conventions are used in this part of the guide as in previous parts, but they are supplemented in places by the following:

[-] This is an IBM PC-XT facility (interrupt, device, register, etc) which is not implemented on **FS/2**.

[+] This is an extra **FS/2** facility (interrupt, device, register, etc), ie one not implemented on the IBM PC-XT.

Chapter 17 Installing Standard Applications

This chapter describes how to select and install third party applications, such as database or PIM packages, etc. Subsequent chapters describe how to install or modify applications which you have developed yourself, or for which you have source code.

17.1 Compatibility

FS/2's industry-standard operating system means that well-behaved MS-DOS or IBM PC applications can be used, provided that they can use the hardware configuration, namely:

Display adaptor type: CGA. Note that the screen is only two-colour, so applications that make extensive use of colours may cause problems.

Memory: The memory available depends on the version of **FS/2**, the memory configuration, the fitting of memory expansion options and use of TSR programs and device drivers. Use the MS-DOS CHKDSK utility to check for free memory.

Check that the application can run within the free DOS memory. If not, fit more memory or re-configure to provide more DOS memory (as described in Part 2). If you have any TSR programs installed (including PRINT or MODE), consider removing them.

Disk: A standard unit is configured with a single disk drive, the RAM disk, as drive C. This behaves like a hard disk.

Check that the application and its data files can fit in the available disk space. If there is insufficient space on drive C, fit more memory or re-configure to provide more disk memory (as described in Part 2).

If the unit is fitted with FLASH EPROM, this is accessed as drive D and behaves like a read-only hard disk. To write information to drive D you must use the FLASHBAK utility; contact Husky Computers or your supplier for details.

Printer: Serial only. **FS/2** does not have a parallel printer port.

Hardware expansion: **FS/2** cannot be expanded by using IBM PC-standard expansion cards. Expansion is limited to internal modules developed by Husky Computers, and external peripherals connected via serial ports.

Certain applications include copy-protection that relies on a specially formatted diskette, or special device (dongle) connected to a parallel printer port. These are unlikely to work on **FS/2**. Such applications are rare, and you may be able to obtain an unprotected version on special request.

In addition, **FS/2** emulates the IBM PC hardware environment, so you can use many 'badly behaved' applications too, such as most TSR packages.

Note: If you are in any doubt about the suitability of a particular package, contact your supplier or Husky Computers, or arrange to test the application (see section 17.4) before committing yourself to purchase.

17.1.1 Problems with interrupts

NMIs: On IBM PCs, NMIs are used for RAM parity errors or not at all, but the **FS/2** uses NMIs for several other purposes. While this is generally not a problem, it can affect the use of certain packages, described here.

If an application redirects the NMI vector, it will crash or hang the **FS/2**. Programs that do this include CODEVIEW and TURBO BASIC (or POWER BASIC). To use such a program, you must patch the code to either prevent redirection or cascade the application's NMI handler from the **FS/2** one. An application's NMI handler is normally used as "catch all" error handlers, eg to catch numeric co-processor errors, on a PC-AT system. (See section 17.1.3 for more information on using POWER BASIC.)

While co-operative task schedulers pose no special problems, pre-emptive task schedulers will also crash or hang **FS/2**. They switch tasks by working off a timer tick, passing a different return cs:pc and flags to the processor. The **FS/2** timer tick is actually generated within the NMI handler, so the return address on the stack is not to the application's code segment, but to the BIOS segment.

Maskable interrupts: Finally, applications which rely on the use of the CLI instruction to mask (disable) all interrupts other than NMI may also cause problems, since NMIs are issued regularly on the **FS/2**, unlike the PC (where it indicates a memory error and halts the system).

17.1.2 Problems with fixed disk structure

Note: To reduce the risk of an application corrupting the RAM disk, always configure a full 640K of RAM as DOS main memory.

While the **FS/2** fixed disks are highly compatible with the MS-DOS structure, there are minor differences which may cause problems, as follows.

Track 0: The disks' data areas are entirely compatible, as are the control areas, with the exception of the partition area, which is limited to a single sector on the first track, while MS-DOS reserves the whole of the first track, allowing specialist OEMs and applications to use the other sectors eg to hold disk fault information.

Read-only areas: The C drive consists of RAM (read-write) and EPROM (read-only) areas. The EPROM area is used for the utilities and COMMAND.COM and MSDOS.SYS. This prevents use of the standard FORMAT/S command on the hard drive, but the **FS/2** UTIL utility works correctly.

TURBO PASCAL programs which attempt to access files in the EPROM area of drive C, or on the optional FLASH EPROM (drive D) will also encounter problems, as the default access mode is read-write. To avoid this problem, add the statement `FILEMODE:=0;` to your programs, to make the default access mode read-only.

Disk parameters: The **FS/2** does not allow applications to change the structure of individual tracks, so programs that employ unusual disk structures, eg as a copy protection mechanism, may fail.

17.1.3 POWER BASIC

NMIs: Spectra Publishing's POWER BASIC, a derivative of Borland's TURBO BASIC, redirects the NMI handler, causing **FS/2** to hang or crash as described above. To run POWER BASIC or POWER BASIC applications on the **FS/2**, you must patch the compiler to disable the NMI redirection as follows:

- Obtain a copy of the PBPREP.EXE program from the Husky Computers Bulletin Board, or any other distribution point, free of charge.
- Copy PBPREP.EXE to the same directory as the PB.EXE compiler and run it. PBPREP makes a backup copy of the compiler (PB-BAK.EXE) and then modifies PB.EXE.
- You can now use the PB compiler to create **FS/2**-compatible applications.

Note that PBPREP does NOT modify the command line compiler PBC.EXE.

Communications: POWER BASIC provides communications support via COMS.COM, but this is not very efficient on the **FS/2**. To improve performance, use the ASYNC.OBJ file which is available from the Husky Computers Bulletin Board, or any other distribution point. For full details of the facilities provided, refer to Husky Technical Note TN287.

Sound: The SOUND and BEEP commands can cause problems with the **FS/2**. To produce a simple beep, use `PRINT CHR$(7);`.

17.2 Porting the application

To use an application, you must load it onto a desktop computer, then use communications to load it onto the **FS/2** RAM disk. See Part 2 for details of loading files with communications.

To make the best use of disk space, only install those files that are really required for operation. For example, don't install tutorial files or drivers for printers that are not going to be used.

17.3 Configuring

Once you have copied the software onto **FS/2** you may have to configure it to suit. Some applications do not need configuring, while others configure themselves automatically.

Refer to the application's installation guide for instructions.

The following brief details may assist you in this. If you need more details, see the full specification in Appendix A.

Display adaptor type: CGA monochrome. If possible, install using a monochrome option.

Operating system: MS-DOS 3.3.

Memory: The memory available depends on the version of **FS/2**, the way memory has been configured, the fitting of memory expansion options and use of TSR programs and device drivers. Use the MS-DOS CHKDSK utility to check.

Remember that some applications can use LIM expanded memory, which is also available as an option.

Processor: V25+ (enhanced 8088), 8MHz clock speed.

Keyboard: Generally compatible with the IBM PC standard keyboard, but with a different layout and omitting some keys.

Disks: The standard **FS/2** disk drive is drive C (the RAM disk). This behaves like a hard disk. Its capacity depends on the version of **FS/2**, the way memory has been configured, and the fitting of memory expansion options. Use the MS-DOS CHKDSK utility to check.

The **FS/2** may also be fitted with FLASH EPROM devices which are accessed as drive D, a read-only drive. (To write to this drive you must use a Husky utility called FLASHBAK; ask your supplier for details.)

Printer: Serial, although you can configure LPT1 as the printer and output will be redirected to COM1 automatically. (**FS/2** does not have a parallel printer port.)

Serial ports: Two. (COM1 and COM2)

As part of the configuration process, you may have to make changes to CONFIG.SYS and AUTOEXEC.BAT. You may find the EDIT utility useful for this. Note that if you change the PATH, you should include C:/ on it if you want to continue to provide easy access to COMMAND.COM, UTIL and EDIT.

FS/2 provides a slightly unusual environment, so note the following when setting up these files:

CONFIG.SYS If you are only using the internal disks (drives C and D), there is no need for a BUFFERS command, since these disks are very fast. This will leave more main memory for your applications.

Standard DOS device drivers (such as ANSI.SYS) are in the C:\DOS directory.

AUTOEXEC.BAT Remember that this file is only executed when **FS/2** is booted. A desktop computer boots each time it is turned on or Ctrl-Alt-Del is pressed, but **FS/2** will normally only reboot if you use emergency breakout or the hardware reset sequence (see Part 2) which ordinary users should not know about (an application will usually disable Ctrl-Alt-Del reboot). Turning off and on will therefore normally restore the same environment eg leaves the current application running, restores the display, environment variables, current directory, etc. (You can change this from within custom applications by using INT 15H, as described later.)

This is generally very helpful, but does mean that you should not rely on AUTOEXEC.BAT to run an application each time **FS/2** is turned on.

17.4 Testing

Once you have installed and configured the application, you should run it and use its main functions briefly, to make sure that operation is correct. In particular, check that:

1 Screen behaviour is acceptable. For example, is text highlighting invisible, or is the LCD screen constantly scrolling to show output in two different areas of the virtual screen? (If there is a problem, see section 17.6.2.)

2 When the user leaves the application or selects a DOS command, it is executed correctly. (If not, check COMSPEC and PATH.)

3 Any utilities that the user or application might need have been installed. (If not, install them.)

4 Printing works correctly, if appropriate. If not, you may need other device drivers (see the application installation instructions) or need to configure communications (see Part 2).

17.5 FS/2 operating system and utilities

The operating system is MS-DOS 3.3. It consists of three files (IO.SYS, MSDOS.SYS and COMMAND.COM), in C:\. These implement all the standard resident commands.

The special utilities (COM, HCOM, I, UTIL and XL) are also stored in C:\, while the following standard MS-DOS files are stored in C:\DOS:

ANSI.SYS	FIND.EXE	MORE.COM
APPEND.EXE	FORMAT.COM	PRINT.COM
ASSIGN.COM	GRAPHICS.COM	REPLACE.EXE
ATTRIB.EXE	GWBASIC.EXE	RESTORE.COM
BACKUP.COM	JOIN.EXE	SORT.EXE
CHKDSK.COM	KEYB.COM	SUBST.EXE
COUNTRY.SYS	KEYBOARD.SYS	SYS.COM
DEBUG.COM	LABEL.COM	TREE.COM
FASTOPEN.EXE	MODE.COM	XCOPY.EXE
FC.EXE		

These files are all read-only, stored in ROM, so you cannot delete them by mistake. To remove access to them, all you can do is remove their directory from the PATH or place dummy files with the same names in any directories the user is likely to use. (This will make access more difficult, but not prevent it.)

If you want to give the user access to standard MS-DOS utilities, copy them onto the RAM disk. The only exception is FORMAT, which you should not provide: use the **FS/2** UTIL command to format disks.

17.6 Special considerations

17.6.1 Batteries

FS/2 will usually be operated from batteries while in the field. Its sophisticated power-saving and monitoring systems will help get the maximum trouble-free operating time from a set of batteries.

You can select two different power management modes:

- Advanced Power Management, which provides continuous power monitoring and controls charging by using charging authorisation levels.
- Standard Power Management, where battery levels are not monitored (apart from the low battery condition) and charging must be controlled by the application.

The **FS/2** is normally supplied with alkaline batteries and APM mode selected, with charging disabled.

Whichever mode you select, if battery power gets very low, **FS/2** will shut down automatically, to avoid losing memory (and RAM disk) contents.

If **FS/2** is fitted with rechargeable batteries, you should normally select Advanced Power Management and charging authorisation level 1, and disable the HOT key. This allows users to monitor power levels but not charge the batteries. Recharging will then be done by the user's technical support department, eg by using the **FS/2 Communications and Charging Rack**. If you want users to be able to charge the batteries, you must warn them not to attempt to recharge Alkaline batteries and select a charging authorisation

level that allows charging, typically level 3 (which will disable charging if they change the batteries). The batteries will typically be recharged overnight. Recharging adjusts the power level automatically.

If **FS/2** is fitted with Alkaline batteries, you may prefer to select Standard Power Management, provide users with a spare set of batteries, and tell them how to change batteries.

Due to the potential risks of attempting to recharge Alkaline batteries, you should only provide responsible personnel with an AC adaptor (see Chapter 32.)

For details of charging and changing batteries, and using the AC adaptor, see Part 2.

17.6.2 Display

As far as practical, the display emulates an IBM CGA screen, but it can only display two colours (black and white) and is not large enough to display the whole screen at one time (it normally moves across a virtual whole screen, to show the latest output).

The emulation will be entirely satisfactory for most uses, but may cause problems when running some standard application.

To help solve such problems, you can use the HOT key, as described in Part 2. For example, if highlighting does not work correctly, you can use the HOT key to display selected screen attributes as inverse video. If you need to display two separate parts of the CGA, you can use the HOT key to split the display into two separate windows, and use a different part of the LCD for each.

For details of using the HOT key, see Part 2. Note that users will not normally have access to the HOT key, so you must set up the display for them.

17.6.3 Training

If a user is running a standard application on **FS/2**, their main source of information must be the application's own guides. However, these may have been written for use on a desktop computer, so users should be made aware of the differences that using **FS/2** will make.

The main points to indicate are:

1 The procedure for battery charging/replacement. (See section 17.6.1.)

2 The modified keyboard key sequences required for certain keystrokes.

3 Controlling the display.

Most of these points are covered in the *FS/2 User Leaflet*, but you may need to supplement this information with the more detailed descriptions in Part 2.

Chapter 18 Adapting Applications

This chapter describes briefly how to adapt applications for which you have the source code so that they will run on **FS/2**. See Chapter 17 for general background on the operating system, utilities, and special considerations. That chapter also describes how to install standard applications.

18.1 Using PC-DOS or MS-DOS software

If you have the source code for a program that was written for MS-DOS, you should be able to compile and run it on **FS/2** without any changes, provided that it meets the criteria described in section 17.1.

For programs that are "well-behaved" ie use the documented BIOS and MS-DOS interrupts for access to the hardware; the minor differences between the **FS/2** hardware and IBM PC hardware should not matter. The **FS/2** MS-DOS interrupts are standard, while the changes to the BIOS are mainly IBM-compatible extensions.

If a program was written specifically for IBM PC or PC-XT hardware, it is more likely to be 'badly behaved' ie to access the hardware directly. The **FS/2** emulation of the IBM PC-XT hardware is very good, but not perfect, so there is a risk that such access will not succeed. For details of the differences, refer to the hardware chapter, at the end of this part of the guide.

Note that limitations are indicated by [-], while enhancements are indicated by [+].

Even if the program will compile and run as it is, you may prefer to modify it to take advantage of some of the extra facilities provided by **FS/2**, such as power management and graphics primitives. These facilities are described in subsequent chapters.

Of particular interest are facilities such as inverse video mapping and keyboard redefinition, which allow you to 'fine-tune' facilities and minimise the need for re-designing standard applications.

18.2 Using BASIC software

There are a wide variety of dialects of the BASIC language, which share the same core but have been extended to provide different ranges of facilities.

As you might expect, programs written in dialects which are closest to the GWBASIC used by **FS/2** are the easiest to convert. The situation with the most relevant dialects is as follows:

BASIC version	Notes
GWBASIC	Programs should run 'as is'. Programs may be in ASCII or tokenised (binary) format. Any assembly language subroutines or direct hardware access used may require slight modifications, as described in section 18.1.
IBM BASIC BASICA	Programs should run 'as is', or with minor changes. Programs may be in ASCII or tokenised (binary) format. Any assembly language subroutines used, or direct hardware access used may require slight modifications, as described in section 18.1.
Husky Portable BASIC	Programs must be rewritten to remove the extra facilities used that are not supported in GWBASIC, such as keyed access file handling. Programs should be saved as ASCII, as different tokens are used by the two dialects. Any assembly language subroutines or direct hardware access used should be completely rewritten in 8086 assembler using the facilities described in the remainder of this guide.
Hunter BASIC	The program must be completely rewritten, although you can use the same basic structure and algorithms if you wish. Any assembly language subroutines or direct hardware access used should be completely rewritten in 8086 assembler using the facilities described in the remainder of this guide.

18.3 Using Hunter 16 software

If you have programs for **Hunter 16** written in GWBASIC, they should run without needing any major changes on **FS/2**, providing they do not use assembly language routines. The main changes you might need to make are to program the keyboard and control the additional **FS/2** facilities, such as the backlight.

If a program is compiled or is written in (or uses) assembly language, it should work correctly, apart from any calls to the functions listed as DELETED or CHANGED below:

Deleted functions

Interrupt	Description
10H, 64H	Get/set backlight level

If a program uses a deleted **Hunter 16** function, the function call will simply be ignored on **FS/2**.

Changed functions

Interrupt	Changes
10H, 60H	Supports bold font
10H, 73H	Supports 11x8 font
14H, 23H	CAUTION: Requires port number in DX
15H, 6DH	Event 0 also generated before auto power down
15H, 6EH	Event 0 also generated before auto power down
15H, 74H	BL is ignored
15H, 81H	CAUTION: Requires port number in BL
16H, 24H	CAUTION: Key matrix codes all different

If a program uses one of the changed functions which starts with CAUTION, it may not operate correctly, for example if a required register is not set correctly.

New functions:

Interrupt	Description
10H, 79H	Reset screen parameters
10H, 7AH	Read contrast and backlight states
10H, 7BH	Set bold attribute mask
14H, 2DH	Set comms level
14H, 2EH	Detect RACK
14H, 2FH	Select RACK/normal comms
14H, 31H	Select modem/normal comms
14H, 32H	Set or clear COM1 Tx bit
14H, 33H	Control COM1 input buffer
14H, 34H	Control 8250 emulation
15H, 8FH	Set volume level
15H, 90H	5V out mark/space duration on power up
15H, 93H	Get charging status
15H, 94H	Reset machine information
15H, 95H	Get machine information
15H, 96H	Control/monitor fast discharge
15H, 97H	Get/set fast discharge override temperature
15H, 98H	Select soft/default font
15H, 99H	Get unit serial number
15H, 9AH	Get customer id
16H, 2FH	Select keyboard
16H, 30H	Reset extra keyboard variables
16H, 31H	Clear keyboard buffer

Chapter 19 The Interrupts

This chapter briefly describes the interrupts used on **FS/2**.

The BIOS interrupts are described in detail in Chapter 20 to Chapter 30. The hardware interrupts are described in section 31.3. The MS-DOS interrupts are described in the *MS-DOS Programmer's Manual*.

19.1 Summary

The V25+ microprocessor (an enhanced version of the 8088) supports 256 different interrupts. There are three types:

- **BIOS interrupts**, instructions executed by programs, as an economical way of calling routines in the BIOS (such as the video display or communications services).
- **Hardware interrupts**, issued by a device manipulating control lines, as a way of requesting service from the BIOS (such as responding to a timer tick or key depression).
- **Microprocessor interrupts**, issued by the microprocessor itself under certain circumstances (such as an attempt to divide by 0 or arithmetic overflow)

All interrupts are vectored from low RAM, to allow an application to service the interrupt with its own routine. The routine can be used to change the normal response to an interrupt, or to provide a response where one is not normally made (as indicated by IRET in the following table). The vectors are restored to their defaults by a cold start (power up in non-resume mode, or after emergency breakout or loss of all power).

The main vector addresses and default contents on **FS/2** are summarised in the following table. To change a vector, you can write direct to memory or use the DOS 'set interrupt vector' function (see the *MS-DOS Programmer's Manual*).

CAUTION: You must not change the vector for INT 2 (which services NMIs), as NMIs are vital to operation of FS/2. If you change this vector, FS/2 will stop operating.

Address	INT	Description	Default vector
00..03H	00H	Divide by 0	IRET
04..07H	01H	Single step	IRET
08..0BH	02H	NMI	NMI routine. **Do not alter!**
0C..0FH	03H	Breakpoint	IRET
10..13H	04H	Arithmetic overflow	IRET
14..17H	05H	Print screen	BIOS print screen
18..1BH	06H	RESERVED	IRET
1C..1FH	07H	FPO instruction	IRET
20..23H	08H	H/W. Time of day	BIOS timer tick routine
24..27H	09H	H/W. Keyboard	Key store routine
28..2BH	0AH	RESERVED	IRET
2C..2FH	0BH	H/W. COM2 port	IRET
30..33H	0CH	H/W. COM1 port	IRET
34..37H	0DH	H/W. Fixed disk	IRET
38..3BH	0EH	H/W. Diskette	Internal UARTs
3C..3FH	0FH	H/W. Printer	IRET
40..43H	10H	Screen control	BIOS video routine
44..47H	11H	Equipment check	BIOS equipment check routine
48..4BH	12H	System memory	BIOS memory size routine
4C..4FH	13H	Disk control	BIOS disk control routine

Address	INT	Description	Default vector
50..53H	14H	Communications	BIOS comms routine
54..57H	15H	Cassette control	BIOS extension routine
58..5BH	16H	Keyboard control	BIOS keyboard control routine
5C..5FH	17H	Printer	BIOS printer routine
60..63H	18H	Not implemented	IRET
64..67H	19H	Bootstrap	BIOS disk bootstrap
68..6BH	1AH	Time of day	BIOS clock/RTC routine
6C..6FH	1BH	Ctrl-Break	IRET
70..73H	1CH	Timer 'tick'	IRET
74..77H	1DH	Video parameters	BIOS video parameters
78..7BH	1EH	Diskette parameters	BIOS diskette parameters
7C..7FH	1FH	Graphics characters	0:0000
80..9CH	20H ..27H	MS-DOS services	See the *MS-DOS Programmer's Manual*
1C0..1C3H	70H	Comms timeout	IRET
1C4..1C7H	71H	Reserved	
1C8..1CBH	72H	Power up/down/reset	Disabled

Note: To use the INT 72H vector, you must also use INT 15H function 87H to link to your routine.

19.2 BIOS interrupts

BIOS interrupts provide convenient access to low-level facilities. The following table summarises the BIOS interrupts provided on **FS/2**. Subsequent chapters describe each one in more detail.

The **FS/2** BIOS interrupts are compatible with the IBM PC-XT BIOS, except where the following symbols appear:

[+] means this interrupt provides facilities in addition to those of the equivalent PC BIOS interrupt. Using these will make better use of **FS/2**'s potential, but may reduce portability of your programs.

[-] means this interrupt does not provide all the facilities of the equivalent PC BIOS interrupt. If you wish to use this interrupt, take careful note of the description of the differences.

If an interrupt has neither of these symbols against it in the following table, you may safely assume that it behaves as in the IBM PC-XT BIOS.

Note: Many of the extra BIOS interrupts are used to change **FS/2**'s behaviour, by altering default settings such as the battery type or keyboard layout. These changes are in general preserved until the next **cold start**. A cold start is produced by a power-up in non-resume mode, or after emergency breakout or loss of all power.

Int	Standard function	Differences
05H	Print (virtual) screen	[+]
10H	Screen control	[+] [-]
11H	Determine system equipment	
12H	Determine system memory	
13H	Disk control	[-]
14H	Serial port control	[+] [-]
15H	BIOS extension function	[+]
16H	Keyboard control	[+]
17H	Printer control	
18H	Activate ROM BASIC/end program	Not implemented
19H	Boot DOS	
1AH	Timer/clock control	[+]

The BIOS interrupts are described in numerical order in the following chapters.

Chapter 20 INT 05H, Print Screen Contents

Use

Dumps the contents of the virtual screen (or LCD screen) to serial port COM1, as ASCII characters ie 'prints' the screen.

Entry

No parameters are passed.

Exit

All registers and flags are preserved.

The status byte at 50:0 in the MS-DOS data segment is set to indicate the result of the operation:

00H - printing is idle or has completed successfully
01H - printing is active. Any further print requests will be ignored
FFH - the previous print operation failed

Comments

This function is normally used by pressing Prtsc or Shift Prtsc, on PC-compatibles.

The main differences on **FS/2** are:

1 The function can be invoked with the default keyboard by pressing Alt P or Ctrl Alt P.

2 The function will print either the whole of the virtual screen, or just that part displayed on the LCD screen (see INT 16H function 27H).

Chapter 21 INT 10H, Screen Handler

Use

Screen control output.

Entry

AH selects the function required, while other registers are used for parameters, as follows. Cursor co-ordinates are range-checked and 'clipped' to keep them within the allowed range (row: 0-24; column: 0-79).

Exit

On exit, AX is corrupted. Other exit conditions are as described for the individual function.

Comments

PC BIOS provides the following functions:

00H	Set screen mode
01H	Set cursor size
02H	Move cursor
03H	Get cursor position
04H	Get lightpen address
05H	Set display page
06H	Scroll up
07H	Scroll down
08H	Read character and attributes
09H	Write character and attributes
0AH	Write character
0BH	Set colour palette
0CH	Write pixel
0DH	Read pixel
0EH	Write character as TTY
0FH	Get video state
10H	EGA/VGA colour palette

11H EGA/VGA character generator
12H EGA/VGA alternate select
13H Write character string

The **FS/2** BIOS provides identical functions, with the following exceptions:

- 04H: replaced by a 'get cursor address' function, as the display hardware does not support a lightpen.
- 0BH: not implemented.
- 10H, 11H and 12H: not implemented.
- 13H: only subfunction 00H.

While these functions are highly compatible, remember that the display hardware is only capable of displaying **two** colours (black and white) and the inverse video attribute. So, while you can use the 'colours' and attributes that each screen mode supports, the visible result is constrained by the hardware.

For example: If a pixel were written with the colour red, it would be displayed as black, but its colour would be read (direct from screen memory or via the appropriate function) as red.

FS/2 also provides a number of extended functions to provide easy access to its special features:

60H Set graphics font
61H Move cursor to graphics co-ordinates
62H Get cursor position in graphics co-ordinates
63H Set contrast
64H Reserved
65H Get/set backlight timeout
66H Split display
70H Draw ellipse/circle
71H Draw line/box
72H Select inverse video mechanism
73H Set text font
74H Set LCD window position
75H Zoom mode
76H Looking keys

77H Get graphics font
78H Turn backlight on/off
79H Reset screen parameters
7AH Get contrast and backlight states
7BH Set bold attribute mask

The IBM extended character set (ASCII codes 128-255) is supported in both graphics modes as well as text modes.

Set screen mode

Entry AH=00H
AL=mode

Description Selects the screen mode, clearing the screen if it is changed. The modes are as follows:

Mode	Description
0	text, 25 x 40, mono
1	text, 25 x 40, colour
2	text, 25 x 80, mono
3	text, 25 x 80, colour
4	graphics, 320 x 200, palette 0
5	graphics, 320 x 200, palette 1
6	graphics, 640 x 200, mono

[-] In text modes, **FS/2** can display text attributes (including colours) as inverse video: see the description of function 72H.

In the colour graphics modes, **FS/2** displays all 'colours' as black or white, as follows:

Colour	Displayed as
0	black
1	white
2	black
3	white

Set cursor size

Entry AH=01H
CH=start scan address (00..1FH)
CL=end scan address (00..1FH)

Exit Returns nothing

Description Changes the cursor size. To make the cursor invisible, set CH to 1FH or set bit 6.

Move cursor

Entry AH=02H
BH=page
DH=row
DL=column

Exit Returns nothing

Description Moves the cursor to the specified row and column of the specified display page.

A second page is only supported in modes 0..3.

Get cursor position

Entry AH=03H
BH=page

Exit CH=start scan address
CL=end scan address
DH=row
DL=column

Description Reads the cursor position.

A second page is only supported in modes 0..3.

Get cursor address [+] [-]

Entry AH=04H
BH=page

Exit DH=row (0..24)
DL=column (0..79)
BX=cursor pixel column (0..639)
CX=cursor pixel row (0..199)
(pixel co-ordinates are for bottom left corner of character cell)

Description Reads the current cursor position, in text and graphics co-ordinates

[+] [-] This function returns the lightpen address, in the IBM BIOS, but **FS/2** does not support connection of a lightpen.

Set display page

Entry AH=05H
AL=page

Exit Returns nothing

Description Selects the display page, in text modes (0..3).

Scroll up

Entry AH=06H
AL=number of lines to scroll
BH=filler attribute
CH=top row
CL=left col
DH=bottom row
DL=right col

Exit Returns nothing

Description Scrolls the area defined by CH, CL, DH and DL, moving it up by the number of lines given by AL, filling the 'blank' lines with the filler character given by BH.

If AL=00H, the area is cleared.

[+] This function works in all screen modes. The IBM BIOS function only works in text modes.

Scroll down

Entry AH=07H
AL=number of lines to scroll
BH=filler
CH=top row

CL=left col
DH=bottom row
DL=right col

Exit Returns nothing

Description As ‘scroll area up’, but scrolls down!

[+] This function works in all screen modes. The IBM BIOS function only works in text modes.

Read character and attributes

Entry AH=08H
BH=page

Exit AH=attribute
AL=character

Description Reads the character at the cursor. The ASCII code is returned in AL, the attribute bits in AH. (Attribute bits are only significant in text mode.)

[+] If you have been using the graphics font facilities (see function 60H), the result will only be meaningful if all characters on the screen are the same size as the current font.

Write character plus attributes

Entry AH=09H
AL=character
BH=page
BL=attribute/colour
CX=repeats

Exit Returns nothing

Description Writes the character specified by AL at the cursor, CX times. The cursor does not move.

In text modes, BL specifies the text attributes. For the 8x6, 12x8 and 12x16 fonts, selected text attributes will be displayed as a bold font. The default is to display the background and foreground intensity bits as bold, but see function 7BH.

In graphics modes, if bit 7 is 0, bits 0 and 1 specify the foreground colour; if bit 7 is 1, the colour specified by bits 0 and 1 is XOR'ed with the current pixel colours.

Write character

Entry
AH=0AH
AL=character
BH=page
CX=repeats

Exit
Returns nothing

Description
As 'write character plus attributes' (function 09H), but the character is written with the current attribute of the cursor position.

Write pixel

Entry
AH=0CH
AL=colour/mode
CX=column
DX=row

Exit
Returns nothing

Description
Writes a single pixel, in graphics modes.

AL dictates the pixel colour as follows. If bit 7 is 0, bits 0 and 1 specify the foreground colour; if bit 7 is 1, the colour specified by bits 0 and 1 is XOR'ed with the current pixel colour.

Read pixel

Entry AH=0DH
CX=column
DX=row

Exit AL=pixel colour

Description Reads the colour of the specified pixel, in graphics modes.

Remember that **FS/2** can only display two colours (black and white), but supports the full range of pixel colours. For example, if a pixel were written with the colour blue, it would be displayed as black, but its colour would be read back as blue.

Write character as TTY

Entry AH=0EH
AL=character
BL=colour (graphics mode only)
BH=page

Exit Returns nothing

Description Writes the character specified by AL, with the colour specified by BL, advancing the cursor afterwards.

Get video state

Entry AH=0FH

Exit AL=mode
AH=width (cols)
BH=page

Description Returns information about the current screen set-up.

Write string [-]

Entry AH=13H
AL=0

BL=attribute
BH=page
DX=starting cursor position
CX=length
ES:BP=address of start of string

Exit Returns nothing

Description Writes a string to the specified position, without moving the cursor. (If you are using a font other than 0, the cursor positioning information is ignored ie the text is output at the current cursor position.)

[+] This function is not provided by the IBM PC BIOS, but is provided by the IBM PC-AT BIOS.

Set graphics font [+]

Entry AH=60H
AL=size (0..6 and 128..134)

Exit BH=cell width
BL=cell height

Description Selects the font (character size) to use for subsequent screen output, in mode 6. If the top bit is set, the characters are output in reverse video. This does not clear the screen, so you can use it to mix different fonts on the screen.

The sizes are as follows:

Font no.	Character (Y x X)	Cell (Y x X)	Co-ordinates (rows x cols)
0 or 128	7 x 7	8 x 8	25 x 80 [40]
1 or 129	7 x 5	8 x 6	25 x 106 [53]
2 or 130	9 x 7	10 x 8	20 x 80 [40]
3 or 131	9 x 14	10 x 16	20 x 40 [20]
4 or 132	18 x 7	20 x 8	10 x 80 [40]
5 or 133	18 x 14	20 x 16	10 x 40 [20]
6 or 134	5 x 3	6 x 4	25 x 160 [80]
7 or 135	7x5	8 x 6	25 x 106 [53]

(Figures in square brackets are for the medium resolution modes.)

The character spacing (cell size) and cursor size adjust to the new font automatically. When you change font, the cursor is left positioned immediately to the right of the last character output, with the same top line, so you should normally position the cursor before you output text in the new font.

This function is ignored in text modes. A related facility is however provided by function 73H.

Font 7 is a bold version of font 1. For more details of these fonts, see Appendix C.

Move cursor to graphics co-ordinates [+]

Entry AH=61H
CX=col
DX=row

Exit Returns nothing

Description Moves the cursor to the specified graphics co-ordinates, in a graphics mode. The position specified is actually the top left corner of the current character cell.

This function is ignored in text modes.

Get cursor position in graphics co-ordinates [+]

Entry AH=62H

Exit CX=col
DX=row

Description Reads the cursor position in graphics co-ordinates, in a graphics mode. The position returned is actually the top left corner of the current character cell.

This function is ignored in text modes.

Set contrast [+]

Entry AH=63H
AL=contrast (0..127)

Exit Returns nothing

Description Sets the LCD screen contrast to improve visibility. The contrast can also be altered by using the contrast keys: ⇧ plus ↑ or ↓.

Get/set backlight timeout [+]

Entry AH=65H
AL=0 (get) or 1 (set)
BX=time (0..012CH) if set

Exit BX=time (0..012CH) if get

Description Gets or sets the time after which the backlight will turn off automatically, if no keys are pressed. The time is specified in seconds, with a maximum of 012CH (5 minutes). 0 specifies no timeout.

Split display [+]

Entry AH=66H
AL=control bits
BH=top row of lower section of LCD (0..7)
BL=top row of lower section of virtual screen (0..24)

Exit Returns nothing

Description Splits the LCD screen horizontally into two parts and assigns each to a separate part of the virtual screen. Each part may be scrollable or fixed.

The control bits are as follows:

D0,D1: if 01, no split. If 10, split.

D2: if 0, no scrolling of top part. If 1, allow scrolling

D3: if 0, no scrolling of bottom part. If 1, allow scrolling

If scrolling is allowed, that part of the LCD will scroll to display output in that part of the virtual screen.

If scrolling is not allowed, that part of the LCD will remain fixed in the current part of the virtual screen (although you can change the view by moving the cursor into the window and using function 74H).

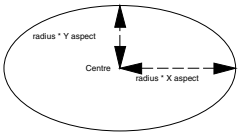
This facility can also be controlled by using the HOT key (◉ Ⓗ).

Draw ellipse/circle [+]

Entry AH=70H
DS=data segment of data buffer
BX=offset into segment

Exit Returns nothing

Description Draws an ellipse or circle in graphics modes. The graphic is drawn according to the data in the buffer, which is as follows:



Byte1: centre X co-ordinate LSB
Byte2: centre X co-ordinate MSB
Byte3: centre Y co-ordinate
Byte4: radius LSB
Byte5: radius MSB
Byte6: colour (0=white, 1=black, 0FFH=invert)
Byte7: aspect ratio x:x factor (1..127)
Byte8: aspect ratio y:y factor (1..127)

The graphics co-ordinates depend on the screen mode, as described for function 0. If any values are out of range, the function is ignored.

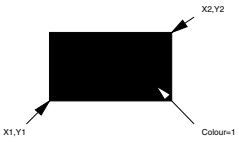
This function is ignored in text modes.

Draw line/box [+]

Entry AH=71H
DS=data segment of data buffer
BX=offset into segment

Exit Returns nothing

Description Draws a line, box or filled box from x1,y1 to x2,y2 in graphics modes. The graphic is drawn according to the data in the buffer, which is as follows:



Byte1: x1 X co-ordinate LSB
Byte2: x1 X co-ordinate MSB
Byte3: y1 Y co-ordinate
Byte4: x2 X co-ordinate LSB
Byte5: x2 X co-ordinate MSB
Byte6: y2 Y co-ordinate
Byte7: colour (0=white, 1=black, 0FFH=invert)
Byte8: type: 0=line, 1=box
Byte9: fill: 0=none, non-0=fill with colour

(fill is only valid if type is box)

The graphics co-ordinates depend on the screen mode, as described for function 0. If any values are out of range the function is ignored.

This function is ignored in text modes.

Select inverse video mechanism [+]

Entry AH=72H
AL=mechanism

Exit Returns nothing

Description Permits use of inverse video to emulate various text screen attributes, according to the value of AL:

AL	Effect
0	Do not use inverse video.
1	Emulate MDA ie display attribute byte 07H as normal video (white on black background) and 70H as inverse video (black on white background).
2	Use inverse video if background colour other than black.
3	Use inverse video for high intensity text.
4	Use inverse video for text with background intensity greater than foreground intensity.
5	Use inverse video for text with background colour other than black or high intensity foreground.

Note that use of this mechanism is entirely transparent to applications: it has no effect on screen memory or functions that read or write text.

In graphics modes, there are no text attributes, so this has no effect.

Select text font [+]

Entry AH=73H
AL=size (0,1,6,7,8,9)

Exit

BH=cell width
BL=cell height

Description

Selects the font (character size) for the entire screen, in a text mode. This displays the whole screen using the new font, allowing you to view more text at one time, at the expense of legibility.

Whatever the font, the entire screen remains 25 lines of 80 columns. The character spacing (cell size) and cursor size are adjusted to the new font automatically.

The sizes are as follows:

Font no.	Character (Y x X)	Cell (Y x X)
0	7 x 7	8 x 8
1	7 x 5	8 x 6
6	5 x 3	6 x 4
7	10 x 7	12 x 8
8	10 x 14	12 x 16
9	7 x 10	8 x 11

Font 1 is the default font, selected when you change screen mode.

Selecting font 0 or 1 has no effect on the screen memory, so it is entirely transparent to applications. In effect, it simply magnifies or reduces the view provided by the LCD screen, so that more or less text is visible at a time.

This function is ignored in graphics modes. A related facility is however provided by function 60H.

Text size can also be changed by using the HOT key (🐾 H).

For more details of these fonts, see Appendix C.

Set LCD window position [+]

Entry AH=74H
DH=row
DL=column

Exit Returns nothing

Description Moves the LCD screen over the virtual screen to position its top left corner at the specified row and column, with row 0, column 0 being the top left corner of the virtual screen and row 25, column 80 being the bottom right corner.

(These row and column co-ordinates are unaffected by changing the text font (size); they are always based on the default 7x7 character matrix.)

Note that this has no effect on the screen memory, so it is entirely transparent to applications.

If the LCD is split (function 66H), this function moves that part of the LCD which is displaying the cursor; the other part of the LCD is unaffected.

Zoom [+]

Entry AH=75H
AL=switch

Exit Returns nothing

Description If AL is 0, turns zoom (screen map) mode off. If AL is not 0, turns zoom mode on.

Zoom mode can also be toggled on or off by using the map key (☎ Ⓜ).

Looking keys [+]

Entry AH=76H
AL=action

Exit Returns nothing

Description Moves the LCD across the virtual screen as if the user had pressed one of the looking keys. The action is dictated by AL, as follows:

AL	Effect
0	home the window
1	move up 1
2	move down 1
3	move left 1
4	move right 1
5	flip window to other side of virtual screen

Get graphics font [+]

Entry AH=77H

Exit AL=font number

Description Returns the currently selected graphics font number in AL. See the description of function 60H for details of font numbers.

Turn backlight on/off [+]

Entry AH=78H
AL=control 0=turn off, non 0=turn on

Exit Returns nothing

Description Turns the LCD backlight on or off. Remember that use of the backlight decreases the battery life considerably.

The backlight can also be toggled on and off by using ⓕⓁ or ⓕ.

Reset screen parameters [+]

Entry AH=79H

Exit CF=0

Description Resets the screen parameters to the following defaults:

Full block cursor
Video mode 2
Reset split screen parameters
Exit map mode
Allow LCD cursor synchronisation
Allow power control in hot key
Allow hot key
Set contrast level to default
Switch backlight off
Set backlight timeout to 2 minutes
Set upper 128 graphics character definitions to BIOS defaults

Get contrast and backlight state [+]

Entry AH=7AH

Exit BH=contrast level (1..80H)
BL=backlight level (0=off, 1=on)

Description Reads the current contrast and backlight states.

Set bold attribute mask [+]

Entry AH=7BH

Exit AL=attribute mask

Description Sets the mask which dictates which text attributes will be displayed as bold, for the 8x6, 12x8 and 12x16 text fonts. Setting a bit to 1 means that if the corresponding character attribute bit is set to 1, the bold font will be used for that character.

Note: The bold attribute mask is reset to 00H by using INT 15H function 98H (redefine soft font), so that bold is not used.

The default attribute mask is 88H, so that characters with the background or foreground intensity bits set will be displayed as bold.

Chapter 22 INT 11H, Check System Equipment

Use

Determines the standard equipment fitted.

Entry

No parameters are passed.

Exit

AX is bit-significant, indicating the equipment fitted. A standard **FS/2** will return the following:

Bit	Significance	Value on FS/2
0	Diskette drives	1 (present)
1	Maths co-processor	0 (absent)
2,3	Base RAM size	11 (64 KByte)
4,5	Initial video mode	10 (80x25 CGA)
6,7	Diskette drives minus 1	01 (one)
8	DMA installed	0 (absent)
9,10,11	Serial ports	010 (two)
12	Game I/O	0 (none)
13	Not used	0
14,15	Printer ports	01 (one)

Comments

This function behaves exactly as it does under PC BIOS.

The equipment list is compiled when MS-DOS is booted.

Chapter 23 INT 12H, Check Memory Size

Use

Reads the amount of main memory.

Entry

No parameters are passed.

Exit

AX=main (DOS) memory size, in KByte. This will be in multiples of 32.

Comments

This function behaves exactly as it does under PC BIOS.

This is the main memory, quite separate from the RAM disk and screen memory. It is affected by the **FS/2** version, memory configuration and fitting of memory expansion modules. (See Part 2 for details.)

Chapter 24 INT 13H, Disk Handler

Use

Disk drive control and I/O.

Entry

AH selects the function required, while other registers are used for parameters, as follows.

Exit

On exit from an operation, if it was successful, CF=0 and AH=00H. If it was unsuccessful, CF=1 and AH indicates the status, as follows:

AH	Status
0	Operation successful
1	Bad command or drive
2	No address mark
3	Write failed to write-protected disk
4	Sector not found
7	Bad parameter table
8	(DMA overrun error: not used)
9	DMA across 64 KByte boundary
0B	Bad track marker detected
10	ECC error
11	ECC error corrected
20	Disk controller error
40	Seek error
80	Disk controller timeout (not ready)
B9	Undefined error
FF	Read status failure

AX and the flags are corrupted.

Comments

The disk functions are as follows:

	PC Standard BIOS	FS/2 Drive C (RAM)	FS/2 Drive D (FLASH)
00H	Reset disk system	yes	yes
01H	Get disk status	yes	yes
02H	Read disk sectors	yes	yes
03H	Write disk sectors	yes	W/P
04H	Verify disk sectors	yes	yes
05H	Format track	yes	W/P
06H	Format with bad sectors	BAD	BAD
07H	Format drive	BAD	BAD
08H	Get drive parameters	yes	yes
09H	Initialise base tables	NO	NO
0AH	Read long	BAD	BAD
0BH	Write long	BAD	BAD
0CH	Seek to cylinder	NO	NO
0DH	Alternate reset	NO	NO
0EH	n/a	BAD	BAD
0FH	n/a	BAD	BAD
10H	Test drive ready	NO	NO
11H	Recalibrate drive	NO	NO
12H	n/a	BAD	BAD
13H	n/a	BAD	BAD
14H	Controller diagnostics	NO	NO
15H	Get disk type	yes	yes
16H	change diskette	NO	NO
17H	n/a	NO	NO
18H	set media type	NO	NO
19H	reserved	yes	yes

Functions described as NO are not implemented but will return with the status set to 0 (operation successful). Functions described as BAD are not implemented and will return with the status set to 1 (bad command). Functions described as W/P will return with status set to 3 (write failed to write-protected disk).

On the **FS/2** drive C, is its fixed (RAM) disk and drive D is the FLASH EPROM option.

Reset disks

Entry AH=00H

Exit AH=status
CF=error flag

Description Recalibrates the disk drive heads. This has no effect on the RAM or FLASH EPROM disks.

Read disk status

Entry AH=01H

Exit AH=status

Description Returns status of the last disk operation.

Read sectors

Entry AH=02H
AL=no. of sectors
BX=offset of read data buffer
ES=segment of read data buffer
DH=head no.
DL=drive no.
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit CF=error flag
AH=status
AL=no. of sectors read

Description Reads the specified sectors to the buffer. These sectors may be on multiple tracks.

If the operation was successful, CF=0 and AH=0.
If the operation was unsuccessful, CF=1 and AH=status byte.

On **FS/2**, drive numbers are 80H (RAM disk: drive C) and 81H (FLASH EPROM disk option: drive D).

Write sectors

Entry

AH=03H
AL=no. of sectors
BX=offset of write data buffer
ES=segment of write data buffer
DH=head no.
DL=drive no.
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit

CF=error flag
AH=status
AL=no. of sectors written

Description

Writes the specified sector(s) from the buffer.

If the operation was successful, CF=0 and AH=0. If the operation was unsuccessful, CF=1 and AH=status byte.

Verify sectors

Entry

AH=04H
AL=no. of sectors
DH=head no.
DL=drive no.
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit

CF=flag
AH=status
AL=no. of sectors verified

Description

If the sector(s) verified correctly, CF=0 and AH=0. If the sector(s) did not verify, CF=1 and AH=status byte.

Format track [-]

Entry

AH=05H
AL=no. of sectors
BX=offset of format data buffer
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=drive no.
ES=segment of format data buffer
ES:BX=ptr to list of address fields

Exit

CF=error flag
AH=status

Description

The PC BIOS allows you to use this function to format individual tracks.

If DL specifies the RAM disk (80H), the sectors specified by the format buffer will be formatted. The format buffer contains a four byte entry for each sector to format:
Byte1=track no.
Byte2=head no.
Byte3=sector no.
Byte4=sector size

If the track(s) formatted correctly, CF=0. If the track(s) did not format correctly, CF=1 and AH gives the cause.

Sector sizes are as follows:
0=128 bytes
1=256 bytes
2=512 bytes
3=1024 bytes

[-]

FS/2 uses 512 byte sectors, so Byte4 must be set to 02H.

Other information required for formatting (such as gap length, filler byte and sectors per track) are obtained from the appropriate disk parameter table.

Read current drive parameters [+]

Entry AH=08H

Exit CH=LSB of max cylinder no.
CL bits 0..5=max number of sectors per track
CL bits 6..7=MSB of max cylinder no.
DH=max head no.
DL=no. of hard disks

Description Returns information about the hard disks fitted.

Get disk type [+]

Entry AH=15H
DL=drive

Exit CX,DX=number of 512 byte sectors if AH=3
AH=disk type

Description Gets the drive type in AH:

0=drive not present
3=fixed disk

If AH=3, CX and DX give the number of 512-byte sectors.

Chapter 25 INT 14H, Serial Port Handler

Use

Serial port control and I/O.

Entry

AH selects the function required, while other registers are used for parameters, as follows.

DX indicates the serial port. As **FS/2** is equipped with two, DX may be 00H (COM1) or 01H (COM2).

Exit

On exit from many of the functions, the AX register indicates the communications status as follows, while the other registers are preserved.

Bits in AH indicates the line status as follows, when set:

Bit	Significance if set
7	Timeout (ignore other bits)
6	Transmit shift register empty
5	Transmit hold register empty
4	Line Break detected
3	Framing error
2	Parity error
1	Overrun error
0	Data ready (or in COM1 input buffer, if enabled)

Bits of AL indicate the modem handshake status as follows, when set:

Bit	Significance
7	Receive line signal detect
6	Ring Indicator (RI)
5	Data Set Ready (DSR)
4	Clear To Send (CTS)
3	Delta Receive line signal detect
2	Trailing edge RI (Ring Indicator)
1	Delta DSR
0	Delta CTS

Comments

IBM PC BIOS provides five functions:

00H Initialise port
01H Send a character
02H Receive a character
03H Get port status
04H Extended initialise port (PS/2-compatible)

FS/2 BIOS provides identical functions, plus a number of extensions, providing access to additional facilities such as higher speeds and protocols:

1EH Read communications parameters
1FH No effect
20H Select communications parameters
21H Extended control
22H Extended status
23H Control handshaking
24H Control CTS
25H Control line drivers
26H Control RI power up
27H Get installed protocols count
28H Get protocol name
29H Get protocol handle
2AH Extended protocol menu
2BH Get extended protocol parameters
2CH Control DTR

2DH Set comms level
2EH Detect RACK
2FH Select RACK comms
31H Select modem comms
32H Set or clear COM1 Tx bit
33H Control input buffering
34H Disable 8250 emulation

For full details of using the RACK, see the *FS/2 Communications and Charging Rack System Developer's Guide*.

Initialise port

Entry AH=00H
DX=port
AL=parameters

Exit AX=status

Description Configures the port specified by DX, according to the bits sets in AL:

D7	D6	D5	Baud
0	0	0	110
0	0	1	150
0	1	0	300
0	1	1	600
1	0	0	1200
1	0	1	2400
1	1	0	4800
1	1	1	9600

D4	D3	Parity
0	0	None
0	1	Odd
1	0	None
1	1	Even

D2	Stop bits
0	One
1	Two

D1	D0	Data bits
0	0	7
0	1	7
1	0	7
1	1	8

Send character

Entry AH=01H
AL=character
DX=port

Exit AX=status

Description Write the character to the port specified by DX.

On return, if bit 7 of AH is 0, the character was sent, otherwise AX indicates the reason for non-transmission. (To check if the reason was a timeout, you must use the ‘Check status’ function.)

Input character

Entry AH=02H
DX=port

Exit AH=status
AL=character

Description Reads a character from the port specified by DX.

If AH=0, the character has been read correctly and is in AL. Otherwise, AH indicates the reason for failure.

Check status

Entry AH=03H
DX=port

Exit AH=line status
AL=modem status

Description Reads the RS232 line and modem status into AX.

Extended initialise port [+]

Entry AH=04H
DX=port
BH=parity
BL=stop bits
CH=data bits
CL=baud rate

Exit AX=status

Description Configures the port specified by DX, according to the other registers:

CL	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400

BH	Parity
0	None
1	Odd
2	Even
3	Odd
4	Even

BL	Stop bits
0	One
1	Two

CH	Data bits
0	7
1	7
2	7
3	8

Note: This function is included for compatibility with the IBM PC-AT and IBM PS/2.

Read comms parameters [+]

Entry AH=1EH
DS=segment address of buffer
BX=offset address of buffer
CX=channel number (00H=COM1, 01H=COM2)

Exit Returns nothing

Description Reads the configuration of the port specified by CX into the buffer specified by DS:BX. This information takes the following format:

Byte0	Effect
0	IBM communications
non 0	Husky communications

Byte1	Port number
0	COM1
1	COM2

Byte2	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400

Byte3	Data bits
1	7
2	8

Byte4	Parity
0	None
1	Odd
2	Even

Byte5	Stop bits
0	One
1	Two

Byte6	Handshake
D7	ignored
D6=1	DCD enable
D5=1	DSR enable
D4=1	CTS enable
D3	ignored
D2=1	DTR enable
D1,D0=00	RTS off
D1,D0=01	RTS hold
D1,D0=10	RTS true
D1,D0=11	ignored

Byte7	Protocol
0	None
1	XON/XOFF
2	HWK3780 (option)

Byte8	Nulls
0..14H	0..20 Nulls after CR

Byte9	LF
0	Off
1	On

Byte10	Serig
0..7FH 80H	Ignore this character Off

Byte11	Echo
0 1	Off On

Byte12	Transmit timeout
0 1..3CH	Off 1..60 seconds

Byte13	Receive timeout
0 1..3CH	Off 1..60 seconds

For details of Husky communications, see Part 2.

Select comms parameters [+]

Entry AH=20H
DS=segment address of buffer
BX=offset address of buffer
CX=channel number (00H=COM1, 01H=COM2)

Exit AX=0 - ok
AX=1 - invalid parameter(s)

Description

Configures the port specified by CX and byte 1 of the buffer, according to the contents of the buffer specified by DS:BX.

Note that both CX and byte 1 must specify the same buffer.

This buffer takes the following format:

Byte0	Effect
0	Select IBM communications
non 0	Select Husky communications

Byte1	Port number
0	COM1
1	COM2

Byte2	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400

Byte3	Data bits
1	7
2	8

Byte4	Parity
0	None
1	Odd
2	Even

Byte5	Stop bits
0	One
1	Two

Byte6	Handshake
D7	ignored
D6=1	DCD enable
D5=1	DSR enable
D4=1	CTS enable
D3	ignored
D2=1	DTR enable
D1,D0=00	RTS off
D1,D0=01	RTS hold
D1,D0=10	RTS true
D1,D0=11	ignored

Byte7	Protocol
0	None
1	XON/XOFF
2	HWK3780 (option)

Byte8	Nulls
0..14H	0..20 Nulls after CR

Byte9	LF
0	Off
1	On

Byte10	Serig
0..7FH	Ignore this character
80H	Off

Byte11	Echo
0	Off
1	On

Byte12	Transmit timeout
0	Off
1..3CH	1..60 seconds

Byte13	Receive timeout
0 1..3CH	Off 1..60 seconds

Byte14	RESERVED

Byte15	RESERVED

Byte16	RESERVED

Byte17	RESERVED

Byte18	RESERVED

For details of Husky communications, see Part 2.

Extended control [+]

Entry AH=21H
AL=command
DX=port

Exit AH=extended status (see ‘Extended status’, below)

Description Used to control buffering. The commands are selected as follows:

AL	Command
AL=1	Force transmission of buffer
AL=2	Clear transmit buffer
AL=3	Clear receive buffer

Extended status [+]

Entry
AH=22H
DX=port

Exit
AH=extended status
BX=number of characters in input buffer
CX=number of characters in output buffer

Description
Used to obtain detailed error information from the current protocol, including the status of the transmit and receive buffers.

The standard protocols (NONE and XON/XOFF) return the most recent error code in AH. For details of the status information returned by other protocols, refer to the protocol documentation.

Protocols will also return error information in the RS232 status byte returned by the standard functions, using the bits which most closely approximate the error they need to report.

Control handshake lines [+]

Entry
AH=23H
BH=line
BL=level
DX=port (00H=COM1, 01H=COM2)

Exit
Returns nothing

Description
Can be used to control the DTR and RTS handshake output lines directly, for the port specified by DX. The specified level remains latched until changed by use of this function or normal communications handshaking.

BH	BL	Effect
0	0	set RTS low
0	1	set RTS high
1	0	set DTR low
1	1	set DTR high

Control CTS [+]

Entry AH=24H
AL=control (0=disable, 1=enable)

Exit Returns nothing

Description Can be used to control sensitivity to the CTS handshake input.

Control RS232 drivers [+]

Entry AH=25H
AL=control (0=turn off, 1=turn on)
DX=port (00H=COM1, 01H=COM2)

Exit Returns nothing

Description Can be used to turn on or turn off the RS232 line drivers, which are required for communication.

The line drivers are normally left turned off when **FS/2** powers up, but turn on automatically when an application transmits or **FS/2** receives handshaking inputs. They then remain turned on until **FS/2** turns off or you use this function.

Use this function to save power by turning off the drivers when communications has finished.

You can also use this function to turn on the drivers before connecting up to a remote system, as **FS/2** may send one or two spurious characters while this is happening, which might confuse the remote system.

Control RI power up [+]

Entry AH=26H
AL=control (0=enable, non 0=disable)

Exit Returns nothing

Description Receipt of the RI handshake will normally power up **FS/2**, allowing a suitable program to respond to devices such as an auto-answer modems.

Use this function to enable or disable this mechanism. This has no effect on reporting of the RI event.

Get installed protocols count [+]

Entry AH=27H
AL=count of extended protocols installed

Exit AL=previous value of protocol count + number of resident installed protocols

Description The purpose of this function is to determine how many protocols are currently installed in **FS/2**. It is used by the UTIL comms menu option to determine how many protocols can be chosen from.

Get protocol name [+]

Entry AH=28H
AL=protocol handle
DS:BX=pointer to 8 character buffer

Exit AH=status (0=pass, FFH=fail)

Description Use this function to read the name of the protocol with the handle stored in AL. On return, if AH is 0 the name is in the 8 character buffer pointed to by DS:BX.

Get protocol handle [+]

Entry AH=29H
DS:BX=pointer to buffer containing name

Exit AH=status (0=pass, FFH=fail)
AL=handle

Description Use this function to read the handle for the protocol whose name is stored in the buffer pointed to DS:BX. On return, the handle is in AL if AH is 0.

Extended protocol menu [+]

Entry AH=2AH
AL=protocol handle

Exit AH=status (0=pass, FFH=fail)
AL=handle

Description Use this function to configure the protocol specified by the handle in AL, by displaying a menu.

Get extended protocol parameters [+]

Entry AH=2BH
AL=protocol handle
DS:BX=pointer to parameter buffer

Exit AH=status (0=pass, FFH=fail)

Description Use this function to read parameters for the protocol with the handle stored in AL. On return, if AH is 0 the parameters are in the buffer pointed to by DS:BX.

Get/set DTR [+]

Entry AH=2CH
AL=0 (get) or non-0 (set)
BL=0 (normal) or non-0 (on), if set
DX=port (00H=COM1, 01H=COM2)

Exit AH=0
BL=0 (normal) or non-0 (on), if get

Description DTR normally goes high while communicating, but may also be controlled by applications accessing the

UART directly. To avoid problems with peripherals that require DTR, you can set it to permanently on by using this function with AL set to 1 and BL set to non zero.

Set comms level [+]

Entry AH=2DH
AL=level (0=RS232, 1=logic level)

Exit Returns nothing

Description Use this function to switch the serial port levels between full RS232 and logic levels. Logic levels save power but may not be compatible with certain applications or peripherals. The default, restored on a cold start, is RS232 levels.

Detect RACK [+]

Entry AH=2EH

Exit AL=0 (RACK not present) or 1 (RACK present)

Description Use this function to detect whether **FS/2** is connected to the **FS/2 Communications and Charging Rack**, so you can begin communications with it (see function 2FH). Note that the rack will only be detected if the **FS/2** unit is fitted with the **Communications Via Charging** option.

Select RACK communications mode [+]

Entry AH=2FH
AL=0 (select normal comms) or 1 (select RACK comms)

Exit Returns nothing

Description Use this function to enable or disable RACK communications mode, if the **FS/2** unit is fitted with

the **Communications Via Charging** option. In RACK communications mode, COM1 I/O is redirected through the charging contacts.

While communications is redirected from Port 1, the Port 1 pins are ignored, Ports 2 and 3 can only provide logic levels (not RS232 levels), and Port 3 CTS cannot be used (although +4.6V out works as normal).

For full details of using the RACK, see the *FS/2 Communications and Charging Rack System Developer's Guide*.

The default mode, restored on a cold start, is normal comms mode with RS232 levels.

Select modem communications mode [+]

Entry AH=31H
AL=control (0=normal comms, 1=modem)

Exit Returns nothing

Description Use this function to enable or disable modem communications mode, if the **FS/2** unit is fitted with the **FS/2 Internal Modem** option. In modem communications mode, COM1 I/O is redirected through the modem.

While communications is redirected from Port 1, the Port 1 pins are ignored, Ports 2 and 3 can only provide logic levels (not RS232 levels), and Port 3 CTS cannot be used (although +4.6V out works as normal).

The default mode, restored on a cold start, is normal comms mode.

Set or clear COM1 Tx bit [+]

Entry AH=32H
AL=control (0=force high, 1=force low)

Exit Returns nothing

Description Use this function to force the COM1 Tx bit high or low.

Control COM1 input buffering [+]

Entry AH=33H
AL=control (0=disable, non-0=enable)

Exit Returns nothing

Description COM1 communications handling can be enhanced by using a 2K input buffer, which stores input transparently to a communications application. Use this function to control this buffering.

With buffering enabled, the BIOS intercepts instructions to poll the line status register to detect data ready, and attempts to read data from the receive holding register so that the input buffer is checked and read from. The data ready bit in the line status register is set if there is any data in the input buffer.

The buffer is flushed automatically if the Baud rate is changed.

The default mode, restored on a cold start, is to enable input buffering.

Control 8250 emulation [+]

Entry AH=34H
AL=control (0=disable, non-0=enable)

Exit AH=0, CF=0 (hardware supports feature)
AH=86H, CF=1 (hardware does not support feature)

Description On suitable hardware, the emulation of the 8250 can be selectively disabled while responding to the COM1 interrupt (IRQ4) by using this function. This allows the application's COM1 interrupt handler to execute faster.

To check if the **FS/2** hardware supports this facility, check the carry flag on return.

With the emulation disabled, the IRQ4 handler must not access any hardware modules other than the 8250 and acknowledging the 8259 ITC.

The default mode, restored on a cold start, is to enable the emulation.

Chapter 26 INT 15H, BIOS Extension Functions [+]

Use

Provides access to additional **FS/2**-specific BIOS functions. These facilities are as follows:

60H Set clock speed
61H Get power level (APM)
62H Set low power threshold (APM)
63H Get/set idle timeout
64H Control Resume mode
65H Authorise charging (APM)
66H Set battery level (APM)
67H Control STOP mode

68H Power down
69H Control power down
6AH Control SLOW mode
6BH Get ROM BIOS version number
6CH Get serial number
6DH Get event details
6EH Enable/trap event
6FH Acknowledge event

70H Control sound
71H Power up keys
72H Redirect serial number
73H Reserved
74H Set backlight power up state
75H Set contrast power up state
76H Control power save
77H Get DOS RAM values

78H Set DOS RAM values
79H Redirect LPT1
7AH Invoke HOT key
7BH Control HOT key
7CH Control HOT key power option
7DH Override power warnings
7EH Control battery change facilities (APM)
7FH Get/set battery type (APM)

80H Set battery capacity (APM)
81H Control power output
82H Sound output
83H Control screen synchronisation
84H Reserved
85H Set/restore power menu (APM)
86H Set attribute table
87H Set INT 72H vector

88H Get power up keys
89H Get/set power management mode
8AH Control power input (SPM)
8BH Set charger temperature override
8CH Get/set power save entry flag
8DH Get/set boost charge (SPM)
8FH Get/set volume level

90H Set 5V mark/space duration
91H Reserved
92H Reserved
93H Get charging status
94H Reset machine information
95H Get machine information
96H Control/monitor fast discharge
97H Get/set fast discharge temperature override

98H Select soft/default font
99H Get unit serial number
9AH Get customer id
9BH Resynchronise timer tick with RTC

Note: Functions marked (APM) only apply to Advanced Power Management. Functions marked (SPM) only apply to Standard Power Management.

Entry

AH selects the function required, while other registers are used for parameters.

Exit

Most of these functions return a status byte in AH, indicating success or failure of the operation:

AH	Operation
0	Successful
FF	Failed

Comments

INT 15 was used in the original IBM PC to implement cassette tape facilities (functions 0..3). In the IBM PC-AT and IBM PS/2 BIOS it is used to implement a variety of enhancements (functions 80..91H). The function numbers have been chosen so as not to clash with the published IBM enhancements.

Many of these functions are used to change the subsequent behaviour of **FS/2**; behaviour remains changed until the next **cold start**, which restores the default (normal) behaviour. (A cold start is produced by a power up in non-resume mode or after using emergency breakout or losing all power.)

Set clock speed [+]

Entry AH=60H
AL=mode

Exit Returns nothing

Description Use this function to alter execution speed, when lower power operation is required and execution speed is not critical.

AL	Speed
0	Normal (8 MHz)
1	Slow mode 1 (4 MHz)
2	Slow mode 2 (2 MHz)

The default, restored by a cold start, is 8 MHz clock speed.

Get power level (APM) [+]

Entry AH=61H

Exit AH=level

Description In Advanced Power Management mode, use this function to read the power remaining, as a percentage of total battery power (ie 0..64H). (In Standard Power Management mode, the battery level is not monitored and this function will always return 7FH.)

Set low power threshold (APM) [+]

Entry AH=62H
AL=level
BX=interval (1..0258H)

Exit AH=status

Description In Advanced Power Management mode, **FS/2** will normally display low power warnings every 5 seconds if the battery level falls to 5%, and turn off automatically after 10 warnings.

Use this function to change the power level at which warnings start, and the interval between warnings:

AL	Level
0..12H	5% to 95%

BX	Interval
1..258H	1 to 600 seconds

Note: Using the HOT key power management option will reset the interval to the default of 5 seconds.

In Standard Power Management mode, this function is ignored; low power warnings are issued when the battery **voltage** falls below a fixed threshold.

Get/set idle timeout [+]

Entry AH=63H
AL=0 (get) or 1 (set)
BX=time (0..0E10H) if set

Exit AH=status
BX=time (0..0E10H) if get

Description **FS/2** will normally turn off automatically if left idle (no keyboard input or communications activity) for 5 minutes.

Use this function to get or set the idle timeout:

BX	Timeout
0	Do not timeout
1..0E10H	1 second to 3600 seconds

Control Resume mode [+]

Entry AH=64H
AL=control

Exit AH=status

Description

FS/2 will normally continue executing the current application when turned off and then turned on again, as if nothing had happened. This is 'resume mode'.

If resume mode is disabled, when **FS/2** is turned on it will display the 'Welcome' screen and boot MS-DOS. This is a cold start and will re-enable resume mode automatically (and set all other settings to their defaults).

Use this function to enable or disable resume mode:

AL	Effect
0	Disable resume mode
1	Enable resume mode

The default, restored by a cold start, is resume mode.

Authorise charging (APM) [+]

Entry

AH=65H
AL=charging level
BH=02H (to
BL=03H minimise
CH=04H risk
CL=05H of
DH=06H inadvertent
DL=07H operation)

Exit

AH=status

Description

FS/2 can be fitted with Alkaline batteries or NiCads. NiCads can be recharged, while Alkaline batteries must not.

In Advanced Power Management mode **FS/2** does not permit recharging by default. (In Standard Power Management mode charging is enabled by default, but you can use function 8AH to disable it.)

Use this function to allow recharging by connecting the AC adaptor, IF YOU ARE SURE THAT RECHARGEABLE BATTERIES ARE FITTED. The charging level is indicated by AL; the contents of the other registers must be as specified, to prevent inadvertent use of this function.

AL	Effect
1	Charging not allowed.
2	Charging allowed until power down (for any reason).
3	Charging allowed until batteries changed (or fail). Ask user if charging allowed when next turned on.
4	Charging allowed indefinitely. USE WITH CAUTION, AS USERS MAY FIT NON-RECHARGEABLE BATTERIES!

Changing the charging authorisation does not enable charging directly; you must enable it by using function 7FH (or the user can use the HOT key power option). Changing the authorisation to 1 will however immediately disable charging.

Once charging is enabled, when the charger is connected, charging will adjust the power level automatically.

If the user changes batteries, their power level must be specified by the user (using the HOT key) or by function 66H.

Note that if all power is removed for long enough to drain the internal backup battery, the charging level will always be reset to 1 (no charging).

The user can also change the charging authorisation (and other battery characteristics) by using the HOT key power option, but you can prevent this by using

function 7BH or 7CH. The user is also prompted to do this after changing batteries, but you can prevent this by using function 7EH.

Set battery level (APM) [+]

Entry AH=66H
AL=level (0..64H)

Exit AH=status

Description In Advanced Power Management (APM) mode **FS/2** monitors battery discharging (and charging, for NiCads) continuously, so that it can maintain an accurate measurement of the current battery level. (In Standard Power Management mode, the battery level is not monitored.)

It also detects when the battery cap has been removed and will normally prompt the user to set the battery characteristics (including the level) when next turned on. This allows the user to specify the new batteries' characteristics when they have been changed. (Although you can suppress this by using function 7EH.)

You can also use this function to set the battery level directly, if you know that the batteries have been changed or have some other reason to believe that the current level is incorrect:

AL	Effect
0..64H	Level (0..100%)

Control STOP mode [+]

Entry AH=67H
AL=mode

Exit AH=status

Description **FS/2** normally enters STOP mode when waiting for keyboard input, to conserve power, or HALT mode if communications is in progress.

Use this function to enable or disable STOP mode. With STOP mode disabled, HALT mode will be used instead, which uses more power but allows communications:

AL	Effect
0	Use STOP mode
1	Use HALT mode

The default, restored on a cold start, is STOP mode.

Power down [+]

Entry AH=68H

Exit Returns nothing

Description If power down is allowed (see function 69H), this turns **FS/2** off. When **FS/2** powers up, it will either boot MS-DOS (if not in resume mode), or return to the application (if in resume mode).

If power down is not allowed, the function will return immediately.

For details of resume mode, see function 64H.

Control power down [+]

Entry AH=69H
AL=mode

Exit AH=status

Description This function can be used to prevent power down due to pressing the ⏻ key, the power down function (68H) or expiry of the idle timeout (see function 63H).

It cannot prevent power down due to power fail or low power.

AL	Effect
0	Inhibit power down
1	Allow power down

Control SLOW mode [+]

Entry AH=6AH
AL=mode

Exit AH=status

Description Use this function to enable or disable selection of SLOW mode:

AL	Effect
0	Inhibit SLOW mode
1	Allow SLOW mode

This would typically be used to stop **FS/2** using SLOW mode for critical periods when you require full speed processing.

The default, restored on a cold start, is to allow SLOW mode.

Get ROM BIOS version number [+]

Entry AH=6BH
DX=0

Exit BH=version number (ASCII)
BL=release number (ASCII)
CH=minor release number (ASCII)
CL=minor release number (ASCII)
DX=machine ID (1=**FS/2**, <>1=not **FS/2**)

Description Use this function to read the ROM BIOS version, release number and machine ID.

Get serial number [+]

Entry AH=6CH

Exit AH=0 (success)
BL=top 2 digits (BCD)
CX=least significant 4 digits (BCD)

Description Use this function to read the serial number. Normally, it will read the number from the unit's ROM, which is the same on every **FS/2** and not very useful. However, you can store a different serial number in RAM and make this function read the RAM version instead, by using function 72H.

Note: For most purposes, it's easier to read the real unit serial number by using function 99H (get unit serial number), as that is guaranteed to be unique and needs no setting up.

Serial numbers can be used to identify the unit in which the program is running (eg for copy-protection purposes).

Get event details [+]

Entry AH=6DH

Exit BX=event flags, bits 0..15
CX=event flags, bits 16..31

Description The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to read the events status. Any enabled events which have occurred but not yet been acknowledged (see function 6FH) will be indicated by setting the appropriate bits in BX and CX (ie event 0 is bit 0, event 1 is bit 1, etc):

Event	Description
0	ⓘ pressed**
1	Error on COM1
2	Error on COM2
3	Data received on COM1
4	Data received on COM2
5	RTC alarm
6	RI received

** Or power down is imminent due to an idle timeout or low power warnings.

(Events are enabled by using function 6EH.)

Enable/trap event [+]

Entry

AH=6EH
AL=software interrupt no.
BH=event number
BL=enable mask

Exit

AH=0 (success)

Description

The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to enable or disable an event, or to trap the event. BH defines the event number to control, BL specifies whether to enable or disable that event:

BL	Effect
0	Disable (ignore) event
1	Enable event

Enabling an event replaces its normal effect. For example, if event 1 is enabled, an error on COM1 will not produce a communications error message. Instead, the corresponding event flag will be set or the trap for that event will be executed.

Disabling an event restores its normal effect. For example, a COM1 error will produce an error message and will no longer set that event flag or execute the trap defined for that event.

AL specifies whether to trap the event:

AL	Effect
0	Do not trap
1..FFH	Trap as software interrupt 1..255

If you trap an enabled event, the corresponding software interrupt will be called when the event occurs. You must define the interrupt service routine (by using the MS-DOS Set Vector function) before trapping the event.

The interrupt service routine MUST NOT execute any MS-DOS or BIOS interrupts and must be short. Typically, it will set a flag within the application which the application polls at regular intervals.

By default, all events are disabled and no events are trapped. The defaults are restored on a cold start.

Acknowledge event [+]

Entry AH=6FH
AL=event number

Exit AH=0 (success)

Description The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to acknowledge an event when you are about to service it. This resets the corresponding bit in the event status bytes, so you can detect the next occurrence of this event.

Control sound [+]

Entry AH=70H
AL=0 (disable) or non-0 (enable)

Exit Registers unchanged

Description Use this function to control ALL sound output, whether instigated by an application or BIOS. (Use function 8FH to change the sound level.)

Power up keys [+]

Entry AH=71H
BL=column (see below)
BH=row (see below)
AL=column switch (0=disable, 1=enable)
CL=row switch (0=disable, 1=enable)

Exit AH=status

Description Use this function to define one or more extra power up keys, by specifying their row and column numbers.

You can define as many keys as you wish. For example, by repeated calls, you could define ALL keys as power up keys, so pressing any key would turn **FS/2** on.

The key row and column numbers are summarised in the following table.

Note that these keys will only power up **FS/2**; they will not power down.

The default, restored by a cold start, is for only the ⓘ key to be a power up key.

Row	Col 0	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
7	-	-	-	-	PgUp	E	K	Q	Sp	right ⇧	left ⇧
6	-	-	←	PgDn	A	F	L	R	W	"	"
5	-	-	-	↑	B	G	M	S	X	"	"
4	-	-	☼	⏎	C	H	N	T	Y	"	"
3	-	6	⊙	D	5	I	O	U	Z	"	"
2	Del	9	2	→	↓	J	P	V	Clr	"	"
1	F4	8	3	-	F2	-	F3	0	-	"	"
0	-	7	4	-	F1	-	Esc	1	-	"	"
	Ⓓ										

Redirect serial number [+]

Entry AH=72H
AL=0 (reset) or non-0 (set)
DS=segment address of serial number
BX=segment offset of serial number

Exit AH=0 (success)

Description By default, each **FS/2** has the same 6-digit serial number stored in ROM, but serial numbers can be stored in the RAM. These can then be used to identify the unit which a program is running on (eg for copy-protection purposes). These serial numbers are read by using function 6CH.

Use this function to change the serial number read routine so that it returns the serial number stored in the RAM, or reset it to read the standard serial number.

Store the serial number as six consecutive bytes, with each byte specifying a decimal digit in ASCII (ie in the range 30H (0) to 39H (9)).

Note: More usefully, the unit's actual serial number can be read by using function 99H (get unit serial number).

The default, restored by a cold start, is to use the ROM serial number, which is identical on all units.

Set backlight power up state [+]

Entry AH=74H
AL=mode (1=off, 2=same level, 3=on)

Exit AH=status

Description Use this function to specify how the backlight should be set when **FS/2** is next turned on.

The default level, restored by a cold start, is 0.

Set contrast power up state [+]

Entry AH=75H
AL=mode (1=off, 2=same level, 3=level as BL)
BL=level (0..7FH)

Exit AH=status

Description Use this function to specify how the LCD contrast should be set when **FS/2** is next turned on.

The default level, restored by a cold start, is 0.

Control power save [+]

Entry AH=76H
BX=control

Exit Registers unchanged

Description **FS/2** enters power save modes under a variety of conditions. Use this function to control those conditions. BX defines the conditions. If bit 0 is 0, **FS/2** will not enter power save; if bit 0 is 1, power save is enabled but individual causes can be inhibited by setting bits 1 to 3.

Bit	
D0=0	**FS/2** will not enter power save
D0=1	power save is enabled and following conditions apply:

Bit	**Inhibits power save:**
D1=1	If waiting for data from COM1
D2=1	If waiting for data from COM2
D3=1	Reserved
D4=1	Inhibit power up on timer tick

FS/2 will normally leave power save mode briefly about 2.5 times a second, to increment the system clock counter. Set bit 4 to stop this and reduce power requirements still further.

By default, all power save causes are enabled. This default is restored by a cold start.

Get DOS RAM [+]

Entry AH=77H

Exit BL=blocks (32K) of DOS RAM

Description Use this function to read how many 32KByte blocks of RAM are available for use as DOS RAM.

Set DOS RAM [+]

Entry AH=78H
BL=blocks (32K) of DOS RAM

Exit Returns nothing

Description Use this function to set how many 32KByte blocks of RAM are available for use as DOS RAM.

Redirect LPT1 [+]

Entry AH=79H
AL=port (0=COM1, 1=COM2)

Exit Returns nothing

Description Redirects subsequent LPT1 output to the serial port specified by AL.

Invoke HOT key [+]

Entry AH=7AH

Exit Returns nothing

Description Invokes the HOT key function just like pressing the HOT key (Ⓐlt Ⓗ on the default keyboard). Access is controlled by functions 7BH (inhibit all access) and 7CH (inhibit access to power functions), exactly as if the user pressed the HOT key.

Control HOT key [+]

Entry AH=7BH
AL=control (0=prevent, non 0=allow)

Exit Returns nothing

Description The HOT key allows users to examine and change various aspects of **FS/2**'s set-up. Use this function to prevent access to these facilities.

By default, access is enabled. This default is restored by a cold start.

If you only want to prevent access to the power control facilities (set power level, low power threshold, battery type, capacity and charging authorisation), use function 7CH.

Use of this function does not stop selection of the power option screen after a battery change (see function 7EH if you wish to do this).

Control HOT key power option [+]

Entry AH=7CH
AL=control (0=prevent, non 0=allow)

Exit Returns nothing

Description The HOT key power option allows users to switch between Standard Power Management (SPM) and Advanced Power Management (APM) and once APM is selected, to set the power level, low power threshold, battery type, capacity and charging authorisation. Use this function to prevent access to these facilities while allowing normal use of the other HOT key menu options.

By default, access is enabled. This default is restored by a cold start.

If you want to prevent access to **all** the HOT key facilities, use function 7BH.

Override low power turn off [+]

Entry AH=7DH
AL=control
(0=turn off after 10 warnings
non-0=never turn off)

Exit Returns nothing

Description **FS/2** will normally turn off after issuing 10 consecutive low power warnings. Use this function to disable this automatic power down, while still displaying the warnings. This allows prolonged used in emergency situations.

By default, power down is enabled. This default is restored by a cold start.

In Advanced Power Management mode, you can alter the low power threshold and interval between warnings by using function 62H; a user can also alter the threshold by using the HOT key. In Standard Power Management mode, low power warnings are issued if the battery voltage falls below a fixed threshold.

Control battery change facilities (APM) [+]

Entry

AH=7EH
AL=control 0 (do not prompt) or non 0 (prompt)

Exit

Returns nothing

Description

In Advanced Power Management mode, if the user removes and replaces the battery cap, when **FS/2** turns on again, it will normally prompt for information about the batteries (by displaying the HOT key power option screen - see Part 2). This allows the user to easily change the battery level, capacity and charging authorisation after changing a battery. (In Standard Power Management mode, this mechanism does not operate.)

Use this function to disable this mechanism, so that **FS/2** will simply power up normally. The user can still access these same facilities via the HOT key unless this has been disabled by using function 7BH or 7CH.

An application can also control the power settings directly, by using functions 65H (charging authorisation), 66H (level), 7FH (enable charging) and 80H (capacity).

By default, **FS/2** will prompt for the information. This default is restored by a cold start.

Get/set battery type (APM) [+]

Entry AH=7FH
AL= 0 (get) or non 0 (set)
BL=battery type, if set
(0=non-rechargeable, non 0=rechargeable)

Exit AL=type (0 or 1), if get

Description In Advanced Power Management mode, use this function to enable or disable recharging or check the charging mode. You can only enable charging if the charger authorisation level is higher than 1 (see function 65H). (In Standard Power Management mode, charging is controlled by function 8AH.)

The user can also enable or disable recharging by using the HOT key power option (but see function 7CH) and after changing batteries (but see function 7EH).

The default battery type selected when you first switch to Advanced Power Management mode is non-rechargeable. On a cold start, Standard Power Management mode is selected.

Set battery capacity (APM) [+]

Entry AH=80H
AL=0 (get) or non 0 (set)
BL=capacity (0..32H) if set

Exit BL=capacity (0..32H) if get

Description In Advanced Power Management mode, use this function to get or set the battery capacity directly (ignored in Standard Power Management mode):

BL	Capacity
0	500
2	600
4	700
...	
32H	3000

Note that BL is incremented in steps of 2; if set to an odd number, the low bit is ignored.

The maximum battery capacity is 3000mAh. The default capacity is 1800mAh (BL=1AH), which is restored by a cold start.

Control power output [+]

Entry

AH=81H
AL=0 (off) or non 0 (on)
BL=0 (Port 1) or 1 (Port 2 and 3)

Exit

Returns nothing

Description

Use this function to turn on or off the +4.6V outputs provided by Ports 1, 2 and 3 (see Appendix F for further details). To turn both outputs on, use the function twice.

Use this function to conserve power by turning off peripheral power except when actually used. Note that enabling an output consumes extra power even if there is no load on the output.

CAUTION:

If the FS/2 is charging on the FS/2 Rack and APM mode is selected, you MUST disable power output, as no additional current is available. If SPM mode is selected, power output is limited to 100mA.

The power output will turn off when **FS/2** turns off, but turn on again when **FS/2** turns on. Note that the output on Port 2 is also output on Port 3.

The default state for both outputs is off. This default is restored by a cold start.

Sound output [+]

Entry AH=82H
BX=pitch
DX=length

Exit Returns nothing

Description Use this function to sound a tone of a specified pitch (BX) and duration (DX). These parameters are summarised in the following table.

The length parameter, DX, can be calculated from the following formula:

$$DX = \frac{duration * 666670}{frequency}$$

Sound interrupt pitch parameters

BX (dec)	note	frequency (dec)	BX (dec)	note	frequency (dec)
4803	C	138.810	1430	A#	466.162
4668	C#	142.827	1350	B	493.880
4540	D	146.830	1274	C	523.250
4286	D#	155.560	1203	C#	554.365
4045	E	164.810	1135	D	587.330
3818	F	174.610	1071	D#	622.257
3604	F#	184.996	1011	E	659.260
3401	G	196.000	954	F	698.460
3210	G#	207.654	901	F#	739.990
3030	A	220.000	850	G	783.990
2860	A#	233.081	803	G#	830.609
2700	B	246.940	758	A	880.000
2548	MID C	261.630	715	A#	932.329
2405	C#	277.183	675	B	987.770
2270	D	293.660	637	C	1046.500
2143	D#	311.127	601	C#	1108.749
2022	E	329.630	568	D	1174.700
1909	F	349.230	536	D#	1244.523
1802	F#	369.998	506	E	1318.500
1701	G	392.000	477	F	1396.900
1605	G#	415.307	451	F#	1479.503
1515	A	440.000	425	G	1568.000

For example, to sound middle C for 0.5 seconds, set DX to 1274 decimal and BX to 2548 decimal.

Control screen synchronisation [+]

Entry AH=83H
AL=0 (disable) or non 0 (enable)

Exit Returns nothing

Description The LCD screen window normally tracks screen output to keep the cursor in view. Use this function to enable or disable this screen synchronisation. (For example, you could disable synchronisation if using standard software that moves the cursor to unimportant areas of the screen.)

The default state is enabled. This default is restored by a cold start. Users can also control synchronisation by using the HOT key.

Set/restore power menu (APM) [+]

Entry AH=85H
AL=0 (restore) or 1 (set)
BL=user software interrupt, if set

Exit Returns nothing

Description In Advanced Power Management mode, if level 3 charging authority is selected, when the user removes and refits the battery cap, a prompt will normally be displayed asking if charging should still be enabled. For other levels, the power menu is displayed.

Use this function to execute your own routine instead so you can handle battery changes from within an application. This routine must be vectored via the user interrupt specified by BL.

The default state (restored by a cold start) is for the normal prompt.

Get/set screen attribute table [+]

Entry AH=86H
AL=0 (get) or non 0 (set)
DS:SI=start of attribute table buffer
BX=1234H

Exit AH=0
buffer contains attribute table, if get

Description If you set AL to 0, this function will read the attribute table into the 256 byte buffer pointed to by DS:SI. If you set AL to non-zero, the attribute table will be set to the contents of this buffer.

The first entry in the table is for text attribute 00H, the second for text attribute 01H and so on. Whenever a character is displayed, its character dot data is XORed with the appropriate entry in the table and the result is displayed.

For example, if a character has the attribute 01H and entry 01H in the table is 00H, the character will be displayed as normal; if the entry is FFH, the character will be displayed as inverse video.

The dot data is XORed a row at a time, with the least significant bits of the entry. For example, if the entry is 0FH (00001111), the righthand four pixels of the character will be reversed. In 8x8 mode, the righthand half will be reversed, while in 8x6 mode the righthand two thirds will be reversed.

Users can also select the particular attribute combination to display as reversed, by using the HOT key. This will override changes made by using this function, but you can prevent access by using INT 15 function 7BH.

Note that this function has no effect in graphics modes, since there are no text attributes in graphics modes.

Set INT 72H vector [+]

Entry AH=87H
DS:DX=new service routine

Exit Returns nothing

Description Use this function to execute your own service routine when an INT 72H is issued. The routine starts at the location specified by DS:DX.

Note: You must also use DOS INT 21H function 25H to update the interrupt vector directly.

INT 72H is issued for three different reasons:
1: when the machine is about to turn off
2: when the machine is about to reboot
3: when the machine is powering up in resume mode

In situations 1 and 2, AH=0 on entry. In situation 3, AH=1 on entry. You can use this information to take the appropriate action eg to turn off unsupported internal or external hardware options (AH=0) or turn on and initialise them (AH=1).

The default state (restored by a cold start) is to use the normal INT 72H service routine.

Get power up keys [+]

Entry AH=88H

Exit AH=00H
BX=column bit pattern
CL=row bit pattern

Description Use this function to read which keys are defined as power-up keys. For more details, see the description of function 71H.

Get/set power management mode [+]

Entry AH=89H
AL=0 (get) or 1 (set)
BL=mode (0=SPM, 1=APM), if set

Exit AH=00H
BL=current mode ie 0 (SPM) or 1 (APM), if get

Description Use this function to change or check the current power control mode. Mode 0 is Standard Power Management (SPM) while mode 1 is Advanced Power Management

(APM). Note that users can also change the power control mode by using the HOT key, unless access is disabled by using function 7BH or 7CH.

For details of how operation differs in the two power modes, see Part 2.

The power mode is not altered by a cold start or other events in normal operation.

Control power input (SPM) [+]

Entry

AH=8AH
AL=0 (disable) or non 0 (enable)
SI=1234H (password)
DI=5678H (password)

Exit

AH=00H (success) or 0FFH (failure)

Description

Use this function to enable or disable power input from the AC adaptor, when using Standard Power Management (use function 7FH in Advanced Power Management mode). When power input is disabled, the AC adaptor will not charge batteries or supply power to **FS/2**. This should be used if Alkaline batteries are fitted.

Note that for this function to operate correctly you must also set SI and DI as indicated.

The default, restored on a cold start, is to enable power input.

Set charger temperature override [+]

Entry

AH=8BH
AL=0 (get) or non 0 (set)
BH=maximum temp, if set
BL=minimum temp, if set

Exit

AH=00H (success) or 0FFH (failure)
BH=maximum temp, if get
BL=minimum temp, if get

Description

Use this function to set or check the temperature range within which charging is allowed. BH and BL specify the temperature range and must be in the range 0..7FH, with 0 being -30˚C (-22˚F) and each increment being 1.1˚C (1.98˚F). For example, 20H is 5˚C (41˚F).

The default, restored on a cold start, is to allow charging between 5˚C and 40˚C (41˚F and 104˚F).

Get/set power save entry flag [+]

Entry

AH=8CH
AL=0 (get) or non 0 (set)
BX=mask, if set

Exit

BX=current mask, if get

Description

FS/2 normally enters power save mode to conserve power whenever possible, for example, if an application is simply scanning the keyboard (waiting for input). However, it will not do so if an application is repeatedly accessing other BIOS services since this indicates that it is doing more than waiting for user input.

To allow entry to power save mode even while such accesses are being made, use this function. Set bits in BX to 0 to indicate which services should not prevent power save entry, as follows:

Bit	Service
0	INT 10H (screen services)
1	INT 13H (disk services)
2	INT 14H (comms services)
3	INT 15H (BIOS extension services)
4	INT 1AH (time/date services)
5	INT 21H (DOS services)
6	Direct write to video RAM
7	Access to 8250 UART
8	Access to 8253 (sound)

The default mask (FFFFH) is restored on a cold start, to prevent power save if any of these services is being used.

Get/set boost charge (SPM) [+]

Entry

AH=8DH
AL=0 (get) or non 0 (set)
BH=0 (prevent) or non 0 (allow)

Exit

AH=0 (success) or FFH (failure)
AL=0 (allowed) or non 0 (prevented), if get

Description

In Standard Power Management (SPM) mode, charging is normally at 120mA, but you can use this function to allow a fast (340mA) charging rate for 1 hour, or check if fast charging is allowed. (In Advanced Power Management mode this function is ignored; charging is fast until the battery level reaches 100%.)

Note:

You cannot select fast charging within 6-7 hours of the previous fast charge.

The default, restored on a cold start, is to disable fast charging.

Get/Set volume level [+]

Entry AH=8FH
AL=0 (get) or non 0 (set)
BL=0 (low) or non 0 (high), if set

Exit AL=0 (success)
BL=0 (low) or non 0 (high), if get

Description Use this function to set the speaker volume level to low or high. (Use function 70H to turn sound on or off.)

The default, restored on a cold start, is high volume level.

Set power out mark/space duration [+]

Entry AH=90H
AL=0 (Port 1) or 1 (Port 2 and 3)
BL=0 (disable) or 1..50 (duration)

Exit AH=0 (success) or non 0 (fail)

Description When one of the 4.6V outputs is turned on, it will normally be chopped using a mark/space ratio of 1:4 for 50mSec, to reduce the current surge which might otherwise overload the **FS/2** power supply.

Use this function to change the duration to BL times 10mSec; set BL to disable this mechanism so that the power output comes fully on immediately.

Note: If the load is highly capacitative (up to 1000 microFarads), turn on the other (unused) 4.6V output and wait for the duration, before turning on the output with the load.

The default, restored on a cold start, is a setting of 5 (ie 50mSec).

Get charging status [+]

Entry AH=93H

Exit
AH=0 (success)
AL=0 (not charging) or non 0 (charging)
If charging:
BH=0 (not boost) or non 0 (boost)
BL=0 (SPM) or non 0 (APM)
CH=0 (normal current) or non 0 (trickle)
CL=0..64H (0..100% charge) or 7FH (SPM)

Description
Use this function to check the charging status and battery level.

Reset machine information [+]

Entry
AH=94H

Exit
AH=0 (success) non 0 (failure)

Description
Use this function to initialise or restart the machine information. See function 95H for details.

Get machine information [+]

Entry
AH=95H
ES=segment of buffer pointer
BX=offset of buffer pointer

Exit
AH=0 (success) non 0 (failure)
Buffer format, all numbers in BCD:
dd - day when machine information last reset
mm - month " "
yy - year " "
nn - number of resets
nn - highest temperature (˚C)
nn - lowest temperature (˚C)

Description
Use this function to read the machine information listed above, to keep a check on how the **FS/2** has been used. You should use function 94H to initialise the information before providing the machine to a user, and can also use it to reset the information at later times if you wish.

Control/monitor fast discharge [+]

Entry AH=96H
AL=control (0=start, 1=stop, 2=get status)

Exit AH=0 (success) or non 0 (failure)
AL=status (0=off, 1=on) if get

Description Use this function to control or check the status of fast discharge, which can be used to exercise rechargeable batteries. Fast discharge will only operate in the temperature range set by function 97H.

CAUTION: **This function must be used very carefully; see section 32.2.4 for details on using it.**

The default, restored on a cold start, it to disable fast discharge.

Get/set fast discharge temperature override [+]

Entry AH=97H
AL=control (0=get, non 0=set)
BL=minimum temperature (0..7FH), if set
BH=maximum temperature (0..7FH), if set

Exit AH=0 (success) or non 0 (failure)
BL=minimum temperature (0..7FH), if get
BH=maximum temperature (0..7FH), if get
CL=current temperature, if get

Description Use this function to check or change the temperature range within which fast discharge (see function 96H) is allowed. The main aim is to make sure that when fast discharge ends, charging can begin ie the temperature will be within the charging temperature range (see function 8BH). Typically, the minimum and maximum temperatures should be set the same as for charging, although the maximum may be set up to 10˚C (18˚F) higher to allow for the heat output during discharge.

BL, BH and CL specify temperatures in the range 0..7FH, with 0 being -30˚C (-22˚F) and each increment being 0.85˚C (1.53˚F).

CAUTION: **Fast discharge must be used very carefully; see section 32.2.4 for details on using it.**

The default, restored on a cold start, is to enable fast discharge between 5˚C (41˚F) and 40˚C (104˚F).

Select soft/default font [+]

Entry

AH=98H
AL=control (0=default, non 0=custom font)
DS:BX=segment:offset of custom font table

Exit

AH=0 (success)

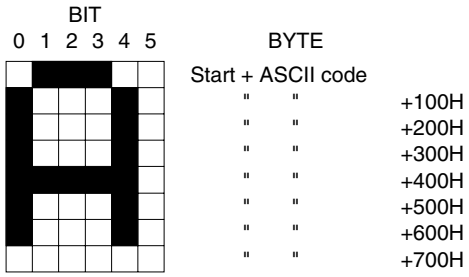
Description

Use this function to select a custom font for text mode in place of the definitions used for the 8x6 fonts and the fonts based on it (8x12 and 16x12), or to return to the default definitions. Doing so also resets the bold attribute mask to 00H so that the bold font is not used (use INT 10H function 7BH).

You must supply a font table for the normal font in the 640K base RAM area with the following format:

Byte 0 - the top row of ASCII 0
Byte 1 - the top row of ASCII 1
..Byte 255 - the top row of ASCII 255
Byte 256 - the second row of ASCII 0
etc, etc.

The table must define all 256 characters, for the 8x6 font (the BIOS derives the other fonts from the 8x6 definitions). Within each byte, the bit order is reversed, ie bit 0 defines the left pixel, bit 1 the next, and so on. Bits 6 and 7 should be set to 0 as the characters are only six pixels wide. For example, the definition of ASCII 65 (A) might look like this:



So the definition for A in this example is:

```
start  +41H = 00001110
start +141H = 00010001
start +241H = 00010001
start +341H = 00010001
start +441H = 00011111
start +541H = 00010001
start +641H = 00010001
start +741H = 00000000
```

If you want to use the bold font, load its definition table into memory immediately after the end of the normal font table ie exactly 800H after its start. Remember to set the bold attribute mask (with INT 10H function 7BH) AFTER selecting the custom font.

Note: The application should select the default font again before exiting, as the next application will probably overwrite the custom font table, producing a scrambled display on the LCD.

The default, restored on a cold start, is to use the default font.

Get unit serial number [+]

Entry AH=99H
ES:DI=pointer to buffer

Exit AH=0 and CF=0 (success) and buffer contains:
byte 0: length of serial number
byte 1..16 (max): serial number
OR
AH=0FFH and CF=1 (failure) and buffer is unchanged

Description Use this function to read the **FS/2**'s unit serial number into the specified buffer. The unit serial number is the same as shown on the unit's label.

Note that the unit serial number is quite distinct from the serial number accessed by functions 6CH and 72H.

Get customer id [+]

Entry AH=9AH
ES:DI=pointer to buffer

Exit AH=0 and CF=0 (success) and buffer contains:
byte 0: length of customer id
byte 1..8 (max): customer id
OR
AH=0FFH and CF=1 (failure) and buffer is unchanged

Description Use this function to read the customer id from the **FS/2**'s EPROM, into the specified buffer. This id can be programmed for you or by using a special utility. Contact your supplier for details. The function will fail if the customer id has not been set.

Resynchronise system clock with RTC [+]

Entry AH=9BH

Exit Returns nothing

Description Use this function to set the system clock to exactly the same time as the RTC.

Chapter 27 INT 16H, Keyboard Handler

Use

Keyboard input and status.

Entry

AH selects the function required, as follows.

Exit

The AX register returns results as shown in the following descriptions. All other registers are preserved. The flags are corrupted.

Comments

The IBM PC BIOS provides the following functions:

00H	Get key	05H	Write to keyboard buffer
01H	Get status	10H	Extended read keystroke
02H	Get shift status	11H	Get extended status
03H	Set key repeat	12H	Get extended shift status

The **FS/2** BIOS provides these functions and also supports a number of extensions, providing access to the following facilities:

20H	Set temporary shift
21H	Control shift keys
22H	Control Ctrl-Alt-Del
23H	Control emergency breakout
24H	Redefine key codes
25H	Reset keyboard
26H	Control keyclick
27H	Control screen dump area
28H	Reserved
29H	Get key repeat
2AH	Control key repeat

2BH Redefine key scan codes
2CH Redefine PAW key codes
2DH Control Ctrl-C and Ctrl-Break
2FH Select keyboard
30H Reset extra keyboard variables
31H Clear keyboard buffer

(Functions 3 and 5 are compatible with the IBM PS/2 BIOS.)

Get key

Entry AH=00H

Exit AH=scan code
AL=character

Description Reads and then removes a keystroke from the keyboard input buffer. (If there is none, the function waits for one.)

The ASCII code is returned in AL. The key scan code is returned in AH. Key codes and scan codes are described in Appendix E.

Get status

Entry AH=01H

Exit ZF=flag
AX=character

Description Checks if there are any characters in the keyboard buffer.

If there is a character, ZF=0 and its ASCII code is returned in AX.

If there is no character, ZF=1.

Note: This function does not remove the character from the buffer.

Get shift status

Entry AH=02H

Exit AL=status

Description Checks the status of the modifier keys and returns the result as separate bits in AL, as follows:

AL	Significance
D7=1	INS mode
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	Alt pressed
D2=1	Ctrl pressed
D1=1	left ⇧ pressed
D0=1	right ⇧ pressed

Set key repeat

Entry AH=03H
AL=05H
BL=typematic rate (0..1FH)
BH=delay (0..3)

Exit Returns nothing

Description Sets the delay before keys repeat, and the rate at which they repeat. The rate (in characters per seconds) is set by BL:

BL	Rate	BL	Rate	BL	Rate	BL	Rate
0	30.0	8	15.0	10	7.5	18	3.7
1	26.7	9	13.3	11	6.7	19	3.3
2	24.0	A	12.0	12	6.0	1A	3.0
3	21.8	B	10.9	13	5.5	1B	2.7
4	20.0	C	10.0	14	5.0	1C	2.5
5	18.5	D	9.2	15	4.6	1D	2.3
6	17.1	E	8.6	16	4.3	1E	2.1
7	16.0	F	8.0	17	4.0	1F	2.0

The delay before a key repeats is set by BH:

BH	Delay
0	250mSec
1	500mSec
2	750mSec
3	1000mSec
4..FFH	Reserved

Write to buffer

Entry AH=05H
CH=scan code
CL=ASCII code

Exit AL=0 (success) or AL=1 (failed, buffer full).

Description Inserts a 16-bit key token in the keyboard input buffer, exactly as if the user had pressed the corresponding key. Scan codes and ASCII codes are summarised in Appendix E.

Extended get key

Entry AH=10H

Exit AL=ASCII code
AH=scan code

Description This function is exactly the same as function 00H. Scan codes and ASCII codes are summarised in Appendix E.

Extended get status

Entry AH=11H

Exit ZF=flag
AL=ASCII code
AH=scan code

Description Checks if there are any characters in the keyboard buffer. If there is a character, ZF=0 and its ASCII code and scan code are returned in AL and AH. If there is no character, ZF=1.

Note: This function does not remove the character from the buffer.

Extended get shift status

Entry AH=12H

Exit AL=status
AH=extra status

Description Checks the status of the modifier keys and returns the result as separate bits in AL and AH, as follows:

AL	Significance
D7=1	INS mode
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	Alt pressed
D2=1	Ctrl pressed
D1=1	left ⇧ pressed
D0=1	right ⇧ pressed

AH	Significance
D7=1	Sys Rq pressed (always 0)
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	right Alt pressed (always 0)
D2=1	right Ctrl pressed (always 0)
D1=1	left Alt pressed
D0=1	left Ctrl pressed

Set temporary shift [+]

Entry AH=20H
AL=shift status

Exit Returns nothing

Description Sets the shift status as indicated by AL:

D4=1	Scroll lock on
D5=1	Num lock on
D6=1	Caps lock on

The user can override the shift status by pressing the appropriate keys.

Control shift keys [+]

Entry AH=21H
AL=keys to control
BL=shift state required

Exit Returns nothing

Description Disables shift keys and sets them to a specified state. The user cannot override the state of disabled keys.

In both AL and BL, individual bits correspond to different keys, as follows:

Bit	Key
7	Ins
6	Caps Lock (C)

5 Num Lock
4 Scroll Lock (Esc)
3 Alt
2 Ctrl
1 Left ⇧
0 Right ⇧

Bits set in AL specify keys to disable. Bits set in BL specify the state to set those disabled keys in.

Control Ctrl-Alt-Del [+]

Entry

AH=22H
AL=control (0=enable, non-0=disable)
BH=7
BL=8
CH=9
CL=10H
DH=11H
DL=12H

Exit

AL=0 (success).

Description

Disables or re-enables Ctrl-Alt-Del, the key combination that usually reboots an MS-DOS computer.

Use this function to prevent a user breaking out of an application unless they know about the emergency breakout sequence. (But also see function 23H).

The other registers must be set as shown for the function to operate. This should prevent accidental operation.

Control emergency breakout [+]

Entry

AH=23H
AL=control (0=enable, non-0=disable)
BH=7
BL=8

CH=9
CL=10H
DH=11H
DL=12H

Exit AL=0 (success).

Description If the user presses the X and P keys while turning on, **FS/2** will usually reboot even if it is locked into a program. This is the emergency breakout mechanism.

Use this function to disable emergency breakout, to prevent a user breaking out of an application. You should also use function 22H to prevent use of Ctrl-Alt-Del.

The other registers must be set as shown for the function to operate. This should prevent accidental operation.

Note: If an application locks up with both emergency breakout and Ctrl-Alt-Del disabled, hold down both ⇧ keys and press ⓘ for at least 4 seconds to produce a hard reset. If this does not work, the unit may be faulty: contact your system supplier for assistance.

Redefine key codes [+]

Entry AH=24H
AL=matrix code of key
BL=new key code

Exit AL=0 (success) or AL<>0 (failed due to out of range parameters).

Description Changes the key code generated by typing the key specified by AL. Each key code is then translated by the INT 9 interrupt handler, into a scan code (which is inserted in the keyboard buffer) or into an immediate action (such as toggle caps lock or turn off).

The matrix codes and key scan codes are summarised in Appendix E.

The standard key matrix is restored on a cold start. You can also restore the default keyboard by using function 25H.

Reset keyboard [+]

Entry AH=25H

Exit AL=0 (success) as cannot fail.

Description Restores the default keyboard mode. This will mainly be used after the keyboard has been redefined by using function 24H.

The default keyboard mode is also restored by a cold start.

Control keyclick [+]

Entry AH=26H
AL=control (0=disable, 1=enable)

Exit AL=0 (success) as cannot fail.

Description Controls production of keyclicks.

Note that keyclicks will also be disabled if sound output is disabled by using INT 15H function 70H, or the MUTE key (Ⓢ).

The default is for keys to click, which is restored by a cold start.

Control screen dump area [+]

Entry AH=27H
AL=control (0=whole (virtual) screen, 1=LCD window)

Exit AL=0 (success) as cannot fail.

Description Controls the area of the screen that will be output when the screen is dumped by using INT 5 or pressing Ⓟ.

The default is to dump the whole screen, which is restored on a cold start.

Get key repeat [+]

Entry AH=29H

Exit BL=typematic rate (0..1FH)
BH=delay (0..3)

Description Gets the delay before keys repeat, and the rate at which they repeat.

The rate (in characters per seconds) is given by BL:

BL	Rate	BL	Rate	BL	Rate	BL	Rate
0	30.0	8	15.0	10	7.5	18	3.7
1	26.7	9	13.3	11	6.7	19	3.3
2	24.0	A	12.0	12	6.0	1A	3.0
3	21.8	B	10.9	13	5.5	1B	2.7
4	20.0	C	10.0	14	5.0	1C	2.5
5	18.5	D	9.2	15	4.6	1D	2.3
6	17.1	E	8.6	16	4.3	1E	2.1
7	16.0	F	8.0	17	4.0	1F	2.0

The delay before a key repeats is given by BH:

BH	Delay
0	250mSec
1	500mSec
2	750mSec
3	1000mSec
4..FFH	Reserved

Control key repeat [+]

Entry AH=2AH
AL=0 (disable) or 1 (enable)

Exit Returns nothing

Description Controls the keyboard autorepeat facility.

The default is for keys to repeat. This default is restored by a cold start.

Redefine key scan codes [+]

Entry AH=2BH
AL=0 (unshifted table), 1 (shifted table) or 2 (numlock table)
BH=standard scan code of key (0..128)
BL=new 8 bit token (ASCII code)

Exit Returns nothing

Description Changes the token generated by any standard key. You can redefine as many keys as you want and define the same token for several keys. For example, you could define the left ⇧ key as Prtsc.

Note that the scan codes are used to identify the keys, NOT ASCII codes, so you can redefine any key to any standard function.

Key scan codes are listed in Appendix E.

The standard key tokens are restored on a cold start. You can also restore the default keyboard by using function 25H, or redefine the keys at a lower level by using function 24H.

Redefine PAW key codes [+]

Entry AH=2CH
AL=matrix code of key
BL=new key code

Exit AL=0 (success) or AL<>0 (failed due to out of range parameters).

Description Changes the key code generated by typing the key specified by AL when the ⎈ key is held down. Each key code is then translated by the INT 9 interrupt

handler, into a scan code (which is inserted in the keyboard buffer) or into an immediate action (such as toggle caps lock or turn off).

The matrix codes used to identify the keys are described under function 24H. Key codes and key scan codes are defined in Appendix E.

The standard key matrix is restored on a cold start. You can also restore the default keyboard by using function 25H.

Control Break keys [+]

Entry AH=2DH
AL=mask
BX=0708H
CX=0910H
DX=1112H

Exit AL=0 (success) or AL=FFH (failed)

Description You can use this function to disable the Break keys and so prevent users breaking out of an application. AL is bit-significant, as follows:

AL	Effect
D0=0	Ignore Ctrl C
D0=1	Normal Ctrl C action
D1=0	Ignore Ctrl-Break (Ctrl Esc)
D1=1	Normal Ctrl-Break action

Normal operation of the Break keys is restored by a cold start.

Select keyboard [+]

Entry AH=2FH
AL=0 (default) or 1 (user)

Exit Returns nothing

Description Use this function to switch between the default (developer) and user keyboard modes.

The developer keyboard provides convenient access to the HOT key and other PAW functions, plus Ctrl and Alt codes, which are not appropriate to most users.

The default keyboard is restored on a cold start.

Reset extra keyboard variables [+]

Entry AH=30H

Exit AL=0 (success)

Description Use this function to reset the extra keyboard variables to their defaults, as follows:

Enable Ctrl Alt Del
Enable key click
Enable autorepeat
Enable Ctrl Scroll lock
⏻ as only power key
Set idle timeout to 5 minutes
Allow emergency breakout
Reset all shifts
Reset all shift locks
Select default (developer) keyboard mode

Clear keyboard buffer [+]

Entry AH=31H

Exit AL=0 (success)

Description Use this function to remove any pending keystrokes from the keyboard buffer.

Chapter 28 INT 17H, Printer Control

FS/2 does not have a parallel printer port, so it redirects all printer access via the BIOS to COM1. It supports the standard printer services.

Use

Printer output and status.

Entry

AH selects the function required and DX selects the printer number, as follows.

Exit

The AH register returns the printer status. Individual bits have the following significance when set:

Bit	Significance	Returns
7	Printer ready	1
6	Printer acknowledge	1
5	Out of paper	0
4	Printer selected	1
3	I/O error	0
2	Not used	0
1	Not used	0
0	Timeout	0, or 1 if a comms error

Note that the only useful status bit is D0, because a serial printer interface cannot return the same amount of status information as a parallel interface.

All other registers are preserved. The flags are corrupted.

Comments

IBM PC BIOS provides three functions:

00H Print byte
01H Initialise printer
02H Get printer status

The **FS/2** BIOS provides identical functions, but note that only one printer is supported (LPT1), which is redirected to COM1 (or COM2; see INT 15H, function 79H) as there is no parallel printer port. Printing is thus subject to the configuration of COM1: handshaking, speed, timeouts, data bits, etc.

Print byte

Entry AH=00H
AL=byte
DX=printer number (0)

Exit AH=status

Description Sends the byte in AL to the printer port and returns the resulting printer status in AH.

Initialise printer

Entry AH=01H
DX=printer number (0)

Exit AH=status

Description Sends BS (08H) and FF (0CH) to initialise the printer and returns the resulting printer status in AH.

Get printer status

Entry AH=02H
DX=printer number (0)

Exit AH=status

Description Returns the current printer status in AH.

Chapter 29 INT 19H, Reboot

Use

Reboot MS-DOS.

Entry

There are no entry parameters.

Exit

There are no exit parameters, as this function does not return.

Comments

This function attempts to reboot MS-DOS from sector 1, track of the RAM disk (drive C). If this fails, the user is asked to insert a system disk.

Note that this reboot is somewhat quicker than a Ctrl Alt Del or power-on reboot, as it bypasses memory checking and reset operations (such as regenerating the equipment list) normally performed during a reboot.

Chapter 30 INT 1AH, Clock Handler [+]

Use

Read or set time, date and alarm.

Entry

AH selects the function required, as follows. Other registers are used for parameters.

Exit

AL, CX and DX are used to return results as described below.

Comments

IBM PC BIOS provides two functions:

00H Get system clock
01H Set system clock

The **FS/2** BIOS provides identical functions and four extra IBM PC-AT BIOS compatible functions to use the RTC:

02H Get RTC time
03H Set RTC time
04H Get RTC date
05H Set RTC date

It also provides four more functions to take advantage of the RTC's alarm functions:

06H Set RTC alarm
07H Disable RTC alarm
09H Get RTC alarm and status
0BH Set system clock source

If the RTC alarm is set, when the alarm time is reached it is reported via the event handling mechanism. It will also power **FS/2** up if it is powered down when the alarm goes off, providing convenient automatic operation in applications such as data logging.

Note that when the system clock is set, the **FS/2** BIOS also sets the RTC clock, and vice versa.

Get system clock

Entry AH=00H

Exit CX=high part
DX=low part
AL=overrun (0=not past midnight, 1=past midnight)

Description Reads the counter maintained by the BIOS. This indicates the number of 'ticks' since midnight. This count is incremented every 54.95mSec (approximately), by BIOS interrupt 8. If counting past midnight, AL is set to non-zero.

The 'Get RTC date' and 'Get RTC time' functions described below are more useful!

Set system clock

Entry AH=01H
CX=high part
DX=low part

Exit Returns nothing

Description Sets the clock count.

Setting the system clock with this function also sets the RTC clock so that the two do not get out of step.

Get RTC time [+]

Entry AH=02H

Exit CH=hour
CL=min
DH=second
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description If the RTC is operating, CF=0 and CH, CL and DH indicate the time, as BCD digits.

If CF=1, the RTC is not operating correctly because it has become corrupted (eg has had invalid data written to it). To resume normal operation, simply set the correct RTC time and date.

Set RTC time [+]

Entry AH=03H
CH=hour
CL=minute
DH=second

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the RTC according to the CH, CL and DH (interpreted as BCD digits).

Setting the RTC also sets the system clock, so that the two do not get out of step.

Get RTC date [+]

Entry AH=04H

Exit CH=century
CL=year
DH=month
DL=day
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description If the RTC is operating, CF=0 and CH, CL, DH and DL indicate the date, as BCD digits.

Set RTC date [+]

Entry AH=05H
CH=century
CL=year
DH=month
DL=day

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the date according to CH, CL, DH and DL (interpreted as BCD digits).

Set RTC alarm [+]

Entry AH=06H
CH=hour
CL=minute
DH=second

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the RTC alarm to the time specified by CH, CL and DH (interpreted as BCD digits).

When the RTC time reaches the alarm time, an alarm event is generated (if that event is enabled) and **FS/2** will power up (if powered down).

You can disable the alarm by using function 7. Note that if the alarm is disabled, setting the alarm with function 6 re-enables it.

For more details of events, see INT 15H functions 6DH..6FH.

Disable RTC alarm [+]

Entry AH=07H

Exit Preserves all registers

Description This function disables the RTC alarm so it does not operate ie does not power up **FS/2** or cause the alarm event.

The default is for the alarm to be enabled. This default is restored on a cold start.

Get RTC alarm time [+]

Entry AH=09H

Exit

CH=hour
CL=minute
DH=second
DL=0 (not enabled) or DL=1 (enabled)
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description

If the RTC is operating, CF=0 and CH, CL and DH indicate the alarm time, as BCD digits, while DL indicates if the alarm is enabled (see function 7).

Set system clock source [+]

Entry

AH=0BH
AL=0 (use DOS tick) non=0 (use RTC)

Exit

Returns nothing

Description

The time can be read from the DOS system clock (tick) or from the RTC; use this function to change the source.

The default, which is restored on a cold start, is to read the time from the RTC, as this is more accurate.

Chapter 31 Hardware

This chapter describes the **FS/2** hardware in sufficient detail to enable you to write programs to control the hardware directly. It will also help you anticipate or diagnose any problems with using software produced for a standard IBM PC-compatible.

It does not provide sufficient information for you to design internal hardware or modify **FS/2** hardware. For this level of information, contact Husky Computers.

For pinouts and other interfacing information, see Appendix F.

31.1 Organisation

The **FS/2** hardware has been designed to satisfy two rather disparate aims:

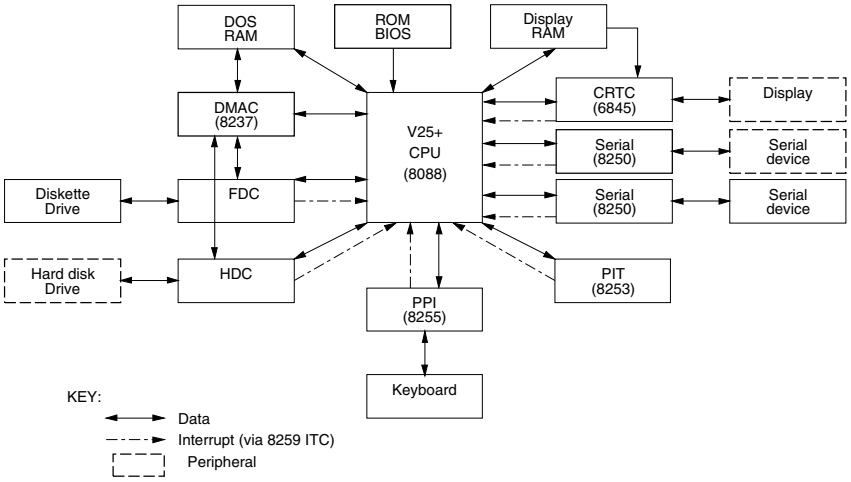
1 Provide the convenience of hand-held operation, in a wide variety of arduous working conditions.

2 Provide a hardware environment similar to a bulky, AC-powered desktop computer, so that programs can be conveniently designed and tested on an IBM PC.

These very ambitious aims have been largely realised, by using miniaturised low-power versions of standard circuitry wherever possible and emulating devices where such devices are not available.

This emulation is performed automatically at a very low level, so that compatibility is not compromised under normal circumstances. Certain device characteristics have not been emulated, for a variety of reasons. These are indicated in the appropriate sections.

The configuration emulated is an IBM PC-XT with CGA graphics adaptor:



These devices are linked by compatible address and data buses, and controlled via compatible hardware interrupts and BIOS.

The **FS/2** design also includes a number of non-standard devices, namely the LCD, electroluminescent backlight, LCD contrast adjustment and power regulation and monitoring system. There is little or no advantage in direct access to these devices, so their hardware implementation will not be described here; use the BIOS interrupts to access these devices (see Chapter 19).

The memory map, hardware interrupts and device emulation details are described in this chapter. For many purposes, the facilities provided by BIOS interrupts will be more convenient (these are summarised in Chapter 19 and detailed in Chapter 20 to Chapter 30).

31.2 Memory maps

The V25+ (enhanced 8088) processor used by **FS/2** can only address 1MB of memory (00000H..FFFFFH). This is its **logical memory map**. (In fact,

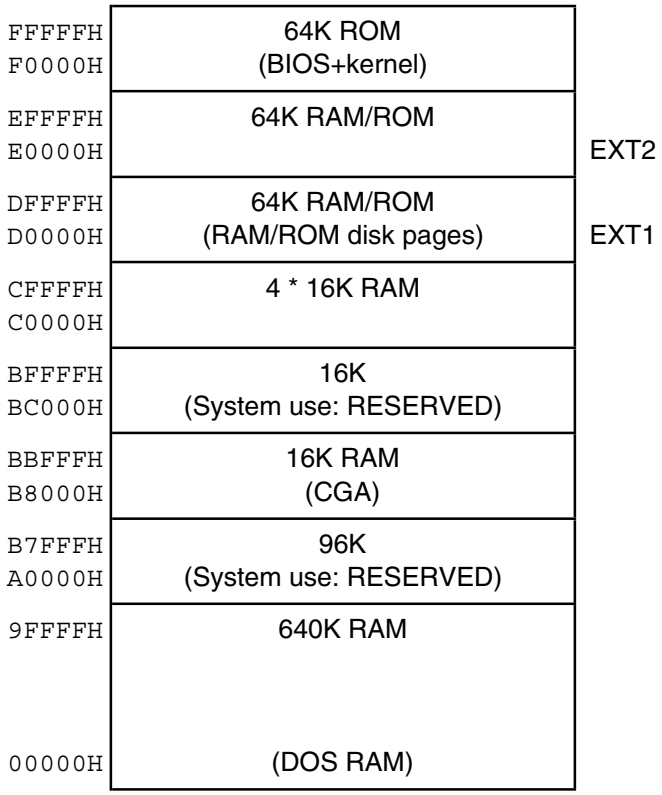
MS-DOS only allows applications to load into the first 640 KByte of this memory (00000H..9FFFFH). This area is usually called the main memory or DOS memory.)

FS/2 can actually address much more memory than this: up to 512 MByte. This is its **physical memory map**.

To access all this additional memory, the processor must map it into the logical memory map, by a process called **paging**. This is used to implement the RAM and ROM disks.

FS/2 also implements IBM PC **I/O addresses**.

31.2.1 Logical memory map



Note that the following areas are reserved for system use and must NOT be written to directly:

E0000..EFFFF
D0000..DFFFF
BC000..BFFFF
A0000..B7FFF

If you require information about these areas, contact Husky Computers for details.

31.2.2 Physical memory map

The physical memory map includes all **FS/2**'s memory-mapped components, including options such as communications and memory expansion modules. Access to these facilities is provided automatically, as and when required, so you do not need information about the physical memory map to use or program **FS/2**.

If your application requires more information about the physical memory map, approach Husky Computers directly.

31.2.3 I/O addresses

An IBM PC only uses I/O addresses 0-3FFH, and these are implemented similarly on **FS/2**. **FS/2** also uses other I/O address, but applications MUST NOT use these!

The following table summarises all the legal I/O operations that can occur on an IBM PC, and indicates those areas which are not fully compatible on **FS/2**. For more details of the individual devices, see section 31.4.

Note: I/O addresses are not fully decoded on an IBM PC, so they are 'reflected' to higher addresses. For example, I/O address 100H could be specified as 100H, 500H, or 900H. **This is not the case on FS/2**.

DMA controller			
Address	**Operation**	**Context**	**Compatible?**
000..00F	Read		NO (ignored)
	Write		NO (ignored)

Interrupt Controller (ITC)			
Address	**Operation**	**Context**	**Compatible?**
020	Read		YES
	Write	Bit 4 set	NO (ignored)
		Bit 4 reset	YES
021	Read		YES
	Write		YES

Timer			
Address	**Operation**	**Context**	**Compatible?**
040	Read		YES
	Write	RL=0	NO (ignored)
		RL=1..3	YES
041	Read		NO (ignored)
	Write		YES (no effect on IBM)
042	Read		YES
	Write	RL=0	NO (ignored)
		RL=1..3	YES
043	Read		YES (no effect on IBM)
	Write		YES

PPI			
Address	**Operation**	**Context**	**Compatible?**
060	Read		YES
	Write		YES (no effect on IBM)
061	Read		YES (no effect on IBM)
	Write		YES
062	Read		YES
	Write		YES (no effect on IBM)
063	Read		YES (no effect on IBM)
	Write		NO (ignored)

DMA Controller			
Address	**Operation**	**Context**	**Compatible?**
080..083	Read		YES (no effect on IBM)
	Write		YES (no effect on IBM)

NMI Mask			
Address	**Operation**	**Context**	**Compatible?**
0A0	Read		YES
	Write		NO (ignored)

Printer			
Address	**Operation**	**Context**	**Compatible?**
378..37A			NO (ignored)

RS232 Port 2			
Address	**Operation**	**Context**	**Compatible?**
2F8	Read		YES
	Write		YES
2F9	Read		YES
	Write	DLAB=0	YES
		DLAB=1	NO (bit 3 ignored)
2FA	Read		NO (bit 3 ignored)
	Write		YES (no effect on IBM)
2FB	Read		YES
	Write		NO (bits 6, 5 ignored)
2FC	Read		YES
	Write		NO (bits 3, 2 ignored)
2FD	Read		YES
	Write		YES (no effect on IBM)
2FE	Read		NO (ignored)
	Write		YES (no effect on IBM

Colour Graphics Adaptor (CGA)			
Address	**Operation**	**Context**	**Compatible?**
3D0	Read		YES
	Write		YES
3D1	Read	index=14..15	YES
		index=other	NO (ignored)
	Write	index=10..15	YES
		index=other	NO (ignored)
3D2 - as 3D0			
3D3 - as 3D1			
3D4 - as 3D0			
3D5 - as 3D1			
3D6 - as 3D0			
3D7 - as 3D1			
3D8	Read		YES (no effect on IBM)
	Write		YES
3D9	Read		YES (no effect on IBM)
	Write		NO (ignored)
3DA	Read		YES
	Write		YES (no effect on IBM)
3DB	Read		YES (no effect on IBM)
	Write		NO (ignored)
3DC	Read		YES (no effect on IBM)
	Write		NO (ignored)

Diskette Controller			
Address	**Operation**	**Context**	**Compatible?**
3F2			NO (ignored)
3F4			NO (ignored)
3F5			NO (ignored)

RS232 Port 1			
Address	**Operation**	**Context**	**Compatible?**
3F8	Read		YES
	Write		YES
3F9	Read		YES
	Write	DLAB=0	YES
		DLAB=1	YES
3FA	Read		YES
	Write		YES (no effect on IBM)
3FB	Read		YES
	Write		YES
3FC	Read		YES
	Write		YES
3FD	Read		YES
	Write		YES (no effect on IBM
3FE	Read		YES
	Write		YES (no effect on IBM)

31.3 Hardware interrupts

The **FS/2** design includes the normal hardware interrupts, vectors and service routines for an IBM PC. For detailed lists, see section 19.1. For more detailed information, refer to standard texts on IBM PC hardware.

The design also includes a number of interrupts that are not present in an IBM PC, which are mainly concerned with the special requirements of a portable computer. Since **FS/2** is not designed for internal expansion by third parties, the details of these interrupts are irrelevant to most third parties and will not be covered here. For details contact Husky Computers.

Application programs can trap hardware interrupts (and other interrupts) by changing the vectors to point into their own code. For details, see section 19.1.

CAUTION: YOU MUST NOT CHANGE VECTOR 02H, which is responsible for servicing NMIs, as NMIs are vital to operation of FS/2. If you change this vector, FS/2 will cease to operate. YOU HAVE BEEN WARNED.

31.4 Device details

As already mentioned, to be considered IBM PC-compatible, a computer must use the same devices, or emulate them. **FS/2** mainly takes the second option, as the devices used in the IBM PC could not be used to produce a convenient portable design.

This section describes the behaviour of the main devices and indicates where the behaviour of the emulations differs sufficiently to compromise compatibility. Where a register is described as 'unimplemented', any attempt at access will simply be ignored.

Note that compatibility extends even to low level access; you are not limited to access via the BIOS.

The V25+ microprocessor is an enhanced version of the 8088 and is entirely 8088-compatible, executing all published instructions. The ROM provides a BIOS that is (as far as practicable) IBM PC-compatible, with extensions to use **FS/2**'s special features; the BIOS is described in Chapter 19 and Chapter 20 to Chapter 30. The RAM is standard, but can be partitioned into two areas: MS-DOS RAM and the RAM disk. These components will not be described further here.

The implementation of the other standard devices will now be described, in the following order:

- CGA (6845 and display RAM)
- 8255 (various)
- 8253 (timer)
- Serial ports (8250)
- Printer interface
- 8237 (DMA)
- 8259 (ITC)
- Disk controllers

For pinouts and other interfacing information, see Appendix G.

31.4.1 CGA and 6845 emulation (display)

The colour graphics adaptor consists of 16 KByte of display memory and seven registers:

Address	Name
3D0	6845 index register (also at 3D2, 3D4 and 3D6)
3D1	6845 data register (also at 3D3, 3D5 and 3D7)
3D8	Mode control
3D9	Colour select
3DA	Status
3DB	Clear lightpen latch
3DC	Preset lightpen latch

31.4.1.1 CGA RAM

The CGA RAM is 16 KByte from B8000H to BFFFFH. It is entirely standard, and will not be described further here, other than to remind you that on **FS/2**, there is no display 'snow' problem, so programs need not wait for the vertical retrace period before accessing the CGA RAM.

Also note that while the **FS/2** LCD can only display monochrome, all colour and attribute bits are implemented in the CGA RAM, to ensure compatibility.

31.4.1.2 6845 registers

The 6845 CRT controller is the core of the CGA. It has 19 internal registers, which are accessed by writing the internal register number to the **6845 index register**, then reading or writing the **6845 data register**.

The 6845 internal registers are implemented as follows:

Register	Access	Description	Implemented?
0	W	Horizontal total	N
1	W	Horizontal displayed	N
2	W	Horizontal sync	N
3	W	Horizontal sync width	N
4	W	Vertical total	N
5	W	Vertical total adjust	N
6	W	Vertical displayed	N
7	W	Vertical sync position	N
8	W	Interlace mode	N
9	W	Max scan line address	N
10	W	Cursor start	Y
11	W	Cursor end	Y
12	W	Start addr (H)	Y
13	W	End addr (H)	Y
14	RW	Cursor addr (H)	Y
15	RW	Cursor addr (L)	Y
16	R	Lightpen (H)	N
17	R	Lightpen (L)	N

The cursor start and end registers specify the size of the cursor by specifying which lines it starts and ends on. The cursor address registers specify the position of the cursor, as the character number (in the range 0..1999). Both these functions are also provided via INT 10H.

Standard texts advise that the other 6845 registers should not be accessed directly, so the fact that they are not emulated should not cause compatibility problems.

31.4.1.3 Mode control register

The mode control register is write-only. When individual bits are set, they have the following effects:

Bit	Effect	Implemented?
7	Not used	-
6	Not used	-
5	Enable blink	N
4	High resolution mode (640x200)	Y
3	Enable video	N
2	Select B&W	N
1	Select graphics	Y
0	Select 80x25 text	Y

31.4.1.4 Colour select register

The colour select register is not implemented, as **FS/2**'s display is only monochrome.

31.4.1.5 Status register

The status register is a read-only register which returns the adaptor's status by setting individual bits as follows:

Bit	Significance	Implemented?
7	Not used	-
6	Not used	-
5	Not used	-
4	Not used	-
3	Vertical retrace	Y
2	Lightpen switch made	N
1	Lightpen trigger set	N
0	Display enabled	Y

Bits 0 and 3 change each time they are read, returning 1xx1, 0xx1, 1xx0, and then 0xx0 before the pattern repeats. Bit 0 is usually checked by programs to time updates to the CGA RAM (to avoid display 'snow'), but there is no 'snow' problem with the **FS/2** CGA.

31.4.1.6 Lightpen registers

The clear lightpen latch and reset lightpen latch registers are not implemented.

31.4.1.7 Character set

The **FS/2** BIOS provides the full IBM character set in both text and graphics modes. The IBM PC BIOS only provides the full set in text modes; in graphics modes, characters 00H..7FH only are defined.

An application can replace the character definitions for ASCII 80..FFH used in graphics modes by changing the contents of vector 1FH (ie 0007CH..0007FH) to point to its own definitions.

31.4.2 8255 emulation (various uses)

The 8255 is a Programmable Peripheral Interface chip, which is involved in the keyboard, sound and system status. It consists of four registers:

Address	Description	Implemented?
060H	Port A (i/p)	Y
061H	Port B (o/p)	Y
062H	Port C (i/p)	Y
063H	Control register	N

31.4.2.1 Control register

The control register is not implemented, so you cannot alter the port configuration, but this is unlikely to cause any problems as applications usually leave it alone.

31.4.2.2 Port A

Port A is an input port. It has two functions, selected by bit 7 of Port B (PB7). When PB7 is set, Port A returns the following information:

Bit	Significance	Implemented?
7	Not used	-
6	Second floppy disk installed	Y
5	Default display mode, bit 1	Y
4	Default display mode, bit 0	Y
3	Not used	-
2	Not used	-
1	8087 present	Y
0	Unused	-

(The value returned, 00101101 binary, indicates that there is no second floppy disk or 8087 installed, and that the default display mode is CGA 80x25 text.)

When bit 7 of Port B (PB7) is 0, Port A returns the scan code of the last key pressed: this is a non-destructive read.

31.4.2.3 Port B

Port B is an output port, but its current contents can also be read. It is used as follows:

Bit	Effect	Implemented?
7	Controls Port A (see above)	Y
6	Enable keyboard clock	N
5	Prevent parity errors causing NMI	N
4	Disable parity checking	N
3	Undefined	-
2	Control Port C (see below)	Y
1	Enable sound output	Y
0	Gate timer 2 on/off	Y

31.4.2.4 Port C

Port C is an input port which returns the following information:

Bit	Significance		Implemented?
7	Onboard parity error		N
6	External parity error		N
5	Output from timer 2		Y
4	Undefined		-
	If PB2=1	**If PB2=0**	
3	RAM3	0	Y
2	RAM2	0	Y
1	RAM1	0	Y
0	RAM0	RAM4	Y

RAM4..RAM0 define the number of 32 KByte blocks of main memory, minus 2 blocks. (Note that this is the MS-DOS main memory, not including RAM configured for use as RAM disk.)

31.4.3 8253 emulation (timers)

The 8253 is a Programmable Interval Timer, used by the IBM PC to implement sound output and system clock. It is implemented as follows:

Address	Description	Implemented?
040H	Timer 0: 18.2 Hz tick	Y
041H	Timer 1: DMA 0 (RAM refresh)	N
042H	Timer 2: tone generator	Y
043H	Control register	Y

31.4.3.1 Control register

The control register controls what effect reading or writing one of the timer registers will have, as follows:

Bits	Effect	Implemented?
7..6	Select timer	Y
5..4	Read/load mode:	Y
	1=read/write LSB	Y
	2=read/write MSB	Y
	3=read/write LSB, then MSB	Y
3..1	Mode:	Y
	0=interrupt on terminal count	N
	1=programmable one-shot	N
	2=rate generator	N
	3=square wave generator	Y
	4=software triggered strobe	N
	5=hardware triggered strobe	N
0	BCD indicator	Y

Note that only mode 3 (square waves) is supported. This is the most commonly used mode.

31.4.3.2 Timer 0

Timer 0 provides the system clock, used for low-level time keeping. Programs can read it or adjust it for their own purposes. Note that the BIOS time of day services use the RTC, which is not affected by the system clock.

31.4.3.3 Timer 1

Timer 1 is not implemented because **FS/2** does not use dynamic RAM, so it does not require a refresh interrupt. Any attempt to read this timer will return the current value of timer 0. Any attempt to write to it will be ignored.

31.4.3.4 Timer 2

Timer 2 can be accessed to produce sound directly. Sound output can be turned on and off by using bits 1 and 0 of Port B. The timer 2 output is also fed back to Port C bit 5, so it can be read directly.

31.4.4 Serial Ports

The IBM PC uses the 8250 to provide an RS232-standard serial port, with the following registers:

Address	Description	Implemented?
3F8H	Buffer/divisor latch LSB	Y
3F9H	Interrupt enable reg/divisor latch MSB	Y
3FAH	Interrupt id register	Y
3FBH	Line control register	Y
3FCH	Modem control register	Y
3FDH	Line status register	Y
3FEH	Modem status register	Y

These addresses are for COM1. COM2 addresses are at 2F8H..2FFH.

FS/2 provides two serial ports: COM1 and COM2.

COM1 is normally routed via Port 1, but may also be routed via the charging contacts (if the **Communications Via Charging** option is fitted), or the optional modem (if fitted), under software control. Routing via a port other than Port 1 imposes certain limitations: refer to the separate **FS/2 Communications and Charging Rack** and **FS/2 Internal Modem** documentation for details.

COM1 is provided by an 8250-compatible UART, so its hardware details are almost entirely standard. **COM1 will not be described in detail within this section,** as you can refer to any standard text on the IBM PC hardware or 8250. The minor deviations will however be described. Two additional facilities are provided for COM1 to enhance throughput: input buffering (see INT 14H function 33H) to improve polled operation, and the ability to turn off the emulation while servicing IRQ4 on suitable hardware (see INT 14H function 34H) to improve interrupt-driven operation.

COM2 is provided by a full hardware emulation of COM2.

Simple communications is supported directly by the IBM PC BIOS. The **FS/2** BIOS provides compatible facilities (as far as practicable), plus a number of additional facilities, such as configurable handshaking and communications protocols, via BIOS extension functions (see Chapter 26).

Note: Selecting Husky communications changes the serial port emulation, so that it will not generate the expected communications interrupts. This is unlikely to cause problems, as any program that is going to use the interrupts will start off by re-programming the interrupt controller and serial port registers; the **FS/2** BIOS will detect this and restore the normal emulation automatically.

31.4.4.1 Main limitations

There are a number of minor differences in the behaviour of the COM2 emulation and a true 8250. The main limitations are:

- Modem status interrupts (other than delta RI) are not generated immediately but shortly after the change in status.
- No 5-bit and 6-bit data
- Parity bit cannot be forced to 1
- No 1.5 stop bit format

31.4.4.2 Buffering

The 8250 provides transmit and receive buffers, accessed as I/O address 3F8H (COM1) and 2F8H (COM2) while the DLAB bit is set to 0 (bit 7 of the line control register). The state of the buffers is indicated by bits in the line status register.

To transmit a byte, write it to the buffer register. It will be copied to the transmit shift register and transmitted if the transmit shift register empty bit (line status register bit 6) is set. If the shift register is not empty, the byte will be copied to the transmit holding register, if this is empty (bit 5 of the line status register).

When the 8250 has finished transmitting a byte, if there is a byte waiting in the holding register, this will be copied into the shift register and the shift register empty bit will be set to indicate that it is empty.

The data ready bit (bit 0) indicates if there is an unread byte in the receive buffer register. When a byte is received, if this is not set, the byte will be placed in the receive buffer register and the data ready bit will be set. If this bit is set when a byte has been received, the overrun bit will be set.

When the application reads a byte from the receive buffer register, the data ready bit is reset automatically.

The COM1 input buffer:

The **FS/2** BIOS provides a 2K input buffer for COM1 only, which is maintained transparently to improve data reception without using interrupt handlers. The data ready bit in the line status register is set to indicate the presence of data in this buffer, while attempts to read data from the receive buffer register will read it from this input buffer. The input buffer is flushed when the Baud rate is changed. This input buffer is enabled by default but can be controlled by using INT 14H function 33H.

31.4.4.3 Divisor latches

The divisor latch for COM1 is accessed as I/O address 3F8H (LSB) and 3F9H (MSB), while the DLAB bit is set to 1 (bit 7 of the line control register). The divisor latch for COM2 is at 2F8H and 2F9H.

It contains a 16-bit number which is multiplied by 1.843 and divided by 16 to give the Baud rate. The commonest uses are as follows:

Rate	Latch	Pre-divide
110	1047	7
150	768	7
300	384	6
600	192	5
1200	96	4
2400	48	3
4800	24	2
96000	12	1
19200	6	0

31.4.4.4 Interrupt enable registers

These are write-only registers which are used to enable interrupts, by setting bits as follows:

Bit	Interrupt	Implemented for COM2?
7	Not used	-
6	Not used	-
5	Not used	-
4	Not used	-
3	Modem status	Y
2	Receive line status	Y
1	Transmit holding register empty	Y
0	Data available	Y

31.4.4.5 Interrupt id registers

When an RS232 interrupt has occurred, read bits 2..0 of the interrupt id register, which indicate the source as follows:

Value	Significance	Clear by reading
0	Modem status	Modem status register
1	No interrupt	-
2	Transmit register empty	Line status register
4	Data available	Receive buffer
6	Line status	Interrupt id register (or write to Tx register)

31.4.4.6 Line control registers

These are output registers, used to control the following details:

Bit	Effect if set	Implemented for COM2?
7	Access divisor latch	Y
6	Set break	N
5	Stick parity (set to NOT bit 4)	N
4	Select even parity	Y
3	Enable parity	Y
2	Stop bits (0=1, 1=2 bits**)	Y
1..0	Word length:	
	00=5 bits	N
	01=6 bits	N
	10=7 bits	Y
	11=8 bits	Y

Note: **If you select a word length of 5 or 6 for COM1, setting bit 2 will select 1.5 stop bits.

If you select 5-bit or 6-bit data, it will be interpreted as 7-bit data.

The parity bits are interpreted as follows:

Enable	Even	Stick	Parity bit (even data)	Parity bit (odd data)
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	1	0
1	0	1	1	1
1	1	0	0	1
1	1	1	1	1

Note that for COM2, if you enable parity and ‘stick’ it, the parity bit is 1 regardless of the ‘Even’ setting.

31.4.4.7 Modem control registers

These are output registers, used to control the following details:

Bit	Effect if set	Implemented for COM2?
7	Unused	-
6	Unused	-
5	Unused	-
4	Enable Loop back	N
3	Out 2	Y
2	Out 1	N
1	Enable RTS	Y
0	Enable DTR	Y

Note: Out 1 is not implemented for COM1 either.

31.4.4.8 Modem status registers

These are input registers, whose contents should be interpreted as follows:

Bit	Significance if set	Implemented for COM2?
7	Receive line signal detect (DCD)	Y
6	Ring Indicator (RI)	Y
5	Data set ready (DSR)	Y
4	Clear to send (CTS)	Y
3	Delta Rx line signal detect	Y
2	Trailing edge ring indicator (RI)	Y
1	Delta DSR	Y
0	Delta CTS	Y

31.4.4.9 Line status registers

These are input registers, whose contents should be interpreted as follows:

Bit	Significance if set	Implemented for COM2?
7	Unused	-
6	Transmit shift register empty	Y
5	Transmit holding register empty	Y
4	Break interrupt	Y
3	Framing error	Y
2	Parity error	Y
1	Overrun error	Y
0	Data ready (see note)	Y

Note: With input buffering enabled (see INT 14H function 33H), bit 0 of the COM1 line status register indicates whether data is ready in the **input buffer**.

31.4.5 Parallel printer port

FS/2 does not provide or emulate a parallel printer port; all printing is via serial ports. (See section 31.4.4 for details.)

31.4.6 8237 emulation (DMA controller)

FS/2 does not provide or emulate a DMA controller; all access to DMA controller hardware is ignored.

31.4.7 8259 emulation (Interrupt controller)

The 8259 interrupt controller is normally used in single stage mode, assigning priorities to interrupts and vectoring up to eight devices, as follows:

Level	IBM PC usage	FS/2 usage
0	18.2 Hz timer	Timer
1	Keyboard	Keyboard
2	RTC	Not used
3	COM2	COM2
4	COM1	COM1
5	HDC	Not used
6	FDC	Not used
7	Parallel printer	Not used

The 8259 can be accessed in three ways:

- Initialisation command words
- Operation command words
- Status words

31.4.7.1 Initialisation command words

An initialisation command word (ICW) is a sequence of up to four bytes, issued by writing the first byte to I/O address 020H with bit 4 set, and writing the other bytes to 021H. ICWs are normally tied in very closely with the hardware configuration, which is fixed on **FS/2**, so they will be ignored and the emulator will be configured as on a standard IBM PC:

- 8086 operation
- Single level (not cascaded)
- Normal fully nested (not special)
- Edge-triggered
- Buffered mode - slave
- Normal EOI (not auto)
- Fixed priority (0 highest, 7 lowest)

31.4.7.2 Operation command words

There are three operation command words, which applications may use at any time: OCW1, OCW2, and OCW3.

OCW1 is used to set the interrupt mask. This is issued by writing a byte to 021H with bits set to mask interrupts, as follows:

Bit	Effect if set	Implemented?
7	Mask level 7	Y
6	Mask level 6	Y
5	Mask level 5	Y
4	Mask level 4	Y
3	Mask level 3	Y
2	Mask level 2	Y
1	Mask level 1	Y
0	Mask level 0	Y

OCW2 is used to report the end of an interrupt service routine or alter interrupt priorities. This is issued by writing a byte to 020H as follows:

Bit	Effect if set	Implemented?
7	Rotate priorities	N
6	Specific	N
5	End of interrupt	Y
4	Must be 0	-
3	Must be 0	-
2	Level bit 2	N
1	Level bit 1	N
0	Level bit 0	N

ie facilities to change interrupt priorities are not supported (they are not really necessary, as internal hardware expansion is limited and strictly controlled).

OCW3 is also written to 020H. It is used to set special mask mode, issue a poll command, or select ISR/IRR on read from 020H:

Bit	Effect if set	Implemented?
7	0	-
6	Set special mask mode to bit 5	N
5	0 or 1 = special mask mode	N
4	Must be 0	-
3	Must be 1	-
2	Poll command	N
1	Set RIS state to bit 0	Y
0	0 or 1 = new RR state	Y

ie special mask mode and polling are not supported.

Note that OCW2 and OCW3 are distinguished by the settings of bits 3 and 4.

31.4.7.3 Status words

Three status words can be read from the 8259, as follows:

- The IMR (interrupt mask register) can be read by reading 021H. It returns the current interrupt mask (ie as set by OCW1).
- The IRR (interrupt request register) can be read by resetting the RIS bit using OCW3 and reading 020H. (It will also be returned if OCW3 has not yet been used.) A bit is set in it for each interrupt that has occurred.
- The ISR (in service register) can be read by setting the RIS bit with OCW3, then reading 020H. A bit is set in it for each interrupt if that interrupt has occurred and is not masked off.

When an interrupt service routine issues an EOI, the corresponding bits in the ISR and IRR are reset.

All three status words are fully supported.

31.4.8 Disk controllers

The **FS/2** disk controller hardware is quite unlike that used on the IBM PC, so the IBM PC FDC and HDC are not emulated. This is only likely to affect copy-protection schemes that access the controller directly and utilities that use special disk formatting; most other programs use MS-DOS for disk access!

Any attempts to access the IBM PC disk controller hardware directly will be ignored.

Chapter 32 Using Power Handling

This chapter describes **FS/2**'s sophisticated power monitoring, charging, conservation and control systems. These have no equivalent on a desktop computer.

32.1 The facilities

FS/2 has been designed for convenient and efficient operation, and its sophisticated power handling is a very important part of this.

The power-related facilities fall into the following main categories:

- Power-up
- Power-down
- Power monitoring and charging
- Saving power
- Power output

32.1.1 Power-up

Any of the following can cause a power-up:

- Pressing a power-up key
- The RTC alarm going off
- Receiving RI (eg from an autoanswer modem)
- Plugging in the AC adaptor
- Placing the **FS/2** on the **FS/2 Communications & Charging Rack**
- Performing a hard reset (⇧ ⇧ ⓘ)

Each cause can be enabled or disabled independently under program control, with the exception of hard reset. A program can also determine the reason for power-up, so it can respond appropriately. For example, a program can conserve power by turning off (see the next section) while waiting for a call or the correct time. (See section 32.1.4 for more information on saving power.)

32.1.1.1 Power-up state

When turned on, **FS/2** will normally resume execution from the state at which it was turned off. This is called 'resume mode', and helps make portable operation extremely convenient.

You can cancel resume mode by using INT 15H, function 64H, and **FS/2** will behave more like a desktop computer, rebooting whenever it is turned on. (Resume mode will also be cancelled if all battery power has been exhausted, including the backup battery.)

The contrast level will normally power up set to a value suitable for normal operating conditions, but you can set the power-up state by using INT 15H function 75H.

If the user has removed the battery cap and the **FS/2** was in APM mode, it will normally display the power options HOT key menu when next turned on, to allow the user to specify if the batteries have been changed. You can disable this facility by using INT 15H, function 7EH (this does not stop the user selecting the HOT key manually).

32.1.1.2 Power-up keys

The main power-up key is ⏻. This key cannot be disabled or redefined; if there is any power in the batteries, it will always turn **FS/2** on (although **FS/2** may turn off again immediately, for example if the battery power is below the low power level).

The easiest way to check if ⏻ has caused the power-up is to enable the power key event (using INT 15H function 6EH) before power down, then check the event details on power up, using INT 15H function 6DH.

You can also define other power-up keys, by using INT 15H, function 71H. If you have done this, to determine if one of these is the reason for power up, you must enable the other possible power-up events (RI and alarm) before power down, then check if either is active after power-up; if not, then a power-up key must have been pressed.

32.1.1.3 RI

RI is an input on Port 1 and Port 2 which will normally power up **FS/2** if it goes high. You can disable power-up by using INT 14H function 26H.

One way to check if RI has caused the power up is to enable the RI event (using INT 15H function 6EH) before power down, then check the event details on power up, using INT 15H function 6DH. (Another way is to check the modem status register, using INT 14H function 3.)

32.1.1.4 RTC alarm

The RTC alarm is set by using INT 1AH, function 6. When the RTC time matches the RTC alarm time, it will turn **FS/2** on. You can disable the alarm by using INT 1AH function 07H.

The easiest way to check if the alarm has caused the power up is to enable the alarm event (using INT 15H function 6EH) before power down, then check the event details on power up, using INT 15H function 6DH. (Another, more laborious, way is to read the RTC time and alarm time, using INT 1AH functions 02H and 09H, and compare them.)

32.1.2 Power-down

While turned off, **FS/2** will normally remember the current execution state so that it can restore it when turned on again. This is called 'resume mode'. Resume mode can be disabled by using INT 15H, function 64H, and will be cancelled if all battery power has been exhausted (ie including the backup battery).

FS/2 can power down when:

- The user presses the ⏻ key.
- The battery power falls below the low power threshold, in Advanced Power Management mode.
- The keyboard has not been touched for a period exceeding the idle timeout.
- The power-down function (INT 15H, function 68H) is used.
- The battery voltage falls below approximately 3.3V in Standard Power Management mode.
- The battery voltage falls below approximately 2.6V to 2.7V (this could be caused by a totally flat battery, power loss, removal of batteries, or an excessive peripheral power load).

- More than approximately 400mA is drawn from the +4.6V outputs.

With the exception of the last three conditions, all these causes can be enabled, modified, or disabled under program control. This allows programs to ensure that crucial tasks (such as transmitting or saving a file) are completed before power-down.

32.1.2.1 Power-down key

Pressing the ⏻ key will normally turn **FS/2** off, but this can be prevented by using INT 15H function 69H. (This function also prevents power down by the power-down function and idle timeout.)

32.1.2.2 Low power

In Advanced Power Management mode (see section 32.1.3) if the power level falls below the low power threshold (default 5%), **FS/2** will normally display low power warnings every 5 seconds and turn off automatically after 10 warnings. This provides a large safety margin, by making sure that sufficient battery power remains to protect the memory contents (including the RAM disk and system configuration) for several weeks.

You can change the threshold and interval between warnings by using INT 15H function 62H, and prevent the automatic power down by using INT 15H function 7DH.

The battery level is monitored automatically during charging and discharging of NiCads and during discharging of Alkalines. You can also set the battery level by using INT 15H function 66H; this will normally be used to set the level when changing batteries. You can set the battery type and total capacity by using INT 15H functions 7FH and 80H.

32.1.2.3 Idle timeout

To conserve power, **FS/2** will normally turn off automatically if left idle (no keyboard input or communications activity) for 5 minutes. When the user is ready to continue, he or she can simply press ⏻ to carry on as if nothing had happened.

You can change the timeout period (or disable it entirely) by using INT 15H function 63H. You can prevent the power down by using INT 15H function 69H (which also prevents power down due to the power-down key or function).

32.1.2.4 Power-down function

The power down function (INT 15H function 68H) can be used to turn off **FS/2**. Use it, for example, to save power when a task is complete or to wait for the RTC alarm or an incoming call to turn it on (see section 32.1.1).

This function can be disabled by INT 15H function 69H.

32.1.2.5 Controlling power-down causes

INT 15H function 69H will prevent power-down due to the idle timeout, power-down key or power-down function. Use it, for example, to make sure that the current task is completed before power-down.

Note that this function cannot prevent power-down due to low power (see section 32.1.2.2) or loss of power.

32.1.2.6 Power loss

If the main batteries are removed or fail, or the peripheral power load is too high (the voltage falls below 2.6-2.7V), or the AC adaptor is turned off whilst batteries are below this level, **FS/2** will immediately turn off regardless of the current activities, and will not turn on again until main power is restored.

When main power is restored, you should find that the memory contents, RAM disk files, etc, are all intact and that any program which was running when power was lost will continue executing. This is because **FS/2** has a backup battery fitted internally which is charged from the main power source, that is sufficient to maintain memory contents for at least 2 weeks.

If main power is lost for longer than 2 weeks, data corruption may occur.

32.1.3 Power monitoring and charging

FS/2 provides two distinct power monitoring modes: Standard Power Management and Advanced Power Management. You can select the power mode by using INT 15H function 89H and users can change the mode by using the HOT key Power option.

To prevent users changing power modes or other power settings via the HOT key, use INT 15H function 7BH (to disable the HOT key) or 7CH (to disable the Power option). You can also replace the Power option routine with your own, by using INT 15H function 85H, and monitor charging status, power level, and power monitoring mode by using INT 15H function 93H.

Charging is normally disabled outside the temperature range 5˚C to 40˚C (41˚F to 104˚F) but you can change the range by using INT 15H function 8BH.

For operating details, such as changing batteries and using the AC adaptor, see Part 2.

32.1.3.1 Standard Power Management (SPM)

In Standard Power Management mode, **FS/2** monitors the battery voltage to detect the low power condition. Charging is normally enabled at 120mA, but you can disable charging by using INT 15H function 8AH and enable fast (boost) charging at 340mA for an hour by using INT 15H function 8DH.

32.1.3.2 Advanced Power Management (APM)

In Advanced Power Management mode, **FS/2** monitors power consumption and recharging, so it can calculate the current charge level and help prevent problems with running out of power at a crucial time. This charge level can be read by users (by pressing the HOT key) and programs (using INT 15H function 61H), as a percentage of full charge. Charging is regulated automatically, starting at 340mA and then reducing to a trickle charge (about 60mA) when the batteries are fully charged.

Power level monitoring relies on measuring the current drain during use and the current supplied while charging NiCads. The battery level is thus calculated by subtracting from or adding to the current level. For this to work, **FS/2** must know four other things:

- The initial charge level (typically 0% for new NiCads, 100% for new Alkaline batteries, but may be another figure if part-used batteries are fitted).
- The charging authorisation, which specifies whether charging can be selected, and for how long. (Attempting to charge Alkaline batteries is futile and hazardous.)

- The battery type, which specifies whether charging is allowed now.
- The battery capacity (NiCad capacity is much lower than Alkaline capacity).

This information can be provided by using the power option of HOT key, as described in Part 2. **FS/2** will also prompt for it whenever you turn on after changing batteries. This is very convenient if the unit will only be used by responsible personnel, but is open to abuse by less careful users. For example, a user might be tempted to enter a false power level to avoid low power warnings, risking total power loss.

If you prefer not to provide users with these facilities, you can disable them by using INT 15H functions 7CH and 7EH. You could then provide supervised, restricted access from within the application by using other INT 15H functions described below. Alternatively, you could re-enable the HOT key (using function 7CH) if the user types the correct password, to allow qualified personnel to recharge and swap batteries quickly and easily.

32.1.3.3 APM: Battery power level

To set the power level, use INT 15H function 66H. This should not be necessary when using NiCads, except when fitting a fresh set, but should be used whenever Alkaline batteries are changed, as **FS/2** has no way of knowing the new batteries' power level.

To read the power level, use INT 15H function 61H. This returns a value representing the percentage charge remaining. Remember that this indicates a different charge (and operating time), depending on the battery capacity.

32.1.3.4 APM: Charging authorisation

By default, in APM **FS/2** does not allow charging from the AC adaptor. This is to avoid the risk of attempting to recharge Alkaline batteries.

Once NiCads have been fitted, use INT 15H function 65H to grant charging authorisation, then INT 15H function 7FH to enable charging.

You should typically only grant level 3, which allows charging until the user changes the batteries (or removes and replaces the battery cap), as this will stop users trying to charge Alkaline batteries. Charging must be carefully controlled; see section 32.2.3 for an example.

32.1.3.5 APM: Battery capacity

To change the battery capacity, use INT 15H function 80H. You should only need to do this if the user fits a different type of battery. The capacity should be specified by the manufacturer, but a typical (A size) NiCad has a usable capacity of 1000-1400mAh and a typical Alkaline (AA size) battery has a usable capacity of about 1800mAh.

32.1.3.6 Fast discharge

To maintain (or restore) NiCads' capacity, you can put them through deep discharge/recharge cycles. One of the safest and most convenient ways to do this is to use INT 15H function 96H, which enables a fast discharge mode where the batteries are discharged at approximately 500mA until they reach a low power state. By combining this function with the power and charging control functions (described within this section) while connected to a charger you can provide a robust and efficient system for maintaining battery efficiency.

A related function is the temperature override for fast discharge (INT 15H function 97H), which is used to help make sure fast discharge only operates if the **FS/2** can resume charging when it has finished.

32.1.4 Saving power

To make the best use of its battery capacity, **FS/2** conserves power in a variety of ways, some obvious, some not so obvious. Most of these mechanisms are entirely automatic and have very little impact on users or programming, so they need not concern you. However, if you are writing programs with unusual requirements, you may need to know about the mechanisms described here.

The power-saving aspects fall into the following categories:

- Power modes
- Idle timeouts

- Switchable devices

32.1.4.1 Power modes

FS/2 can operate in a number of different modes, with different power consumption and capabilities, as follows:

Mode	Description
Normal	Normal full speed operation at 8MHz
Slow1	Normal operation but at 4MHz
Slow2	Normal operation but at 2MHz
Halt	Execution stopped, waiting for RESET, NMI or other enable hardware interrupts
Stop	Execution stopped, waiting for RESET or NMI only

While turned on, **FS/2** is usually in NORMAL mode, but switches to STOP mode whenever it is waiting for keyboard input, to conserve power; when a key is pressed, it switches back to NORMAL mode.

As STOP mode does not respond to interrupts other than RESET and NMI, **FS/2** can miss serial data while waiting for keyboard input, if a communications package which relies on interrupts (such as Husky communications) is selected.

To reduce this risk but still save power, **FS/2** will use HALT mode instead of STOP mode, once an application has started communications (ie used INT 14H function 1 or 2).

If you think that there still might be problems, you can force **FS/2** to use HALT mode instead of STOP mode, by using INT 15H function 67H. This will make sure that no interrupts are missed, but uses a little more power.

Normally, if an application is using BIOS services, **FS/2** will remain in NORMAL mode even if there is no user input. To allow use of low power modes even while certain services are being used, use INT 15H function 8CH.

You can also select the two 'slow' modes directly by using INT 15H function 60H, to conserve power at the expense of processing speed. For example, you might select the slowest mode while waiting for an occurrence that cannot be used to turn **FS/2** on (as described in section 32.1.1). Note that this will not conserve power if the processor has a computational task to perform, it will just take longer.

32.1.4.2 Timeouts

FS/2 implements timeouts to conserve power when devices have been idle for a period. These are:

- The keyboard idle timeout. This turns **FS/2** off if the keyboard is not touched for the timeout period and communications is not active (buffers are empty). To change or disable this timeout, use INT 15H function 63H.
- The backlight idle timeout. This turns the backlight off if the keyboard is not touched for the timeout period. To change or disable the timeout, use INT 10H function 65H.

32.1.4.3 Switchable devices

There are several devices which consume significant power, that you can control from programs. You should keep their use to a minimum:

- The backlight. Use INT 10H function 65H to set a timeout and INT 10H function 78H to turn it on and off.
- The RS232 interface. This turns on automatically when needed, but programs should turn it off when not needed, using INT 14H function 25H. Alternatively, switch to using logic levels (rather than RS232 levels) by using INT 14H function 2DH, if the peripheral will work with these levels.
- The optional modem, while enabled or in use.
- The optional **Rack** interface, while enabled or in use. Use INT 14H function 2FH to turn it on and off.
- The +4.6V outputs. Turning these on uses power even when a load is not connected. Use INT 15H function 81H to turn them on and off.

32.1.5 Power output

FS/2 provides two power outputs for operating low power devices, under the control of INT 15H function 81H.

The outputs are on pins 10 (Port 1) and 11 (Port 2) of the 25-way connector, on pin K of the two 12-way connectors, and on pin 9 of the second 9-way connector (Port 2). The Port 2 output is also provided on pin 3 of the 5-way connector. These outputs provide 4.5V to 4.8V at 100 milliamps, falling to 4.0V minimum at the rated maximum of 400 milliamps. Note that this maximum is total current via both outputs.

Power is only output while **FS/2** is switched on and has a programmable soft-start (under control of INT 15H function 90H) to minimise the load on the power supply.

Turning these outputs on consumes additional power even when a load is not connected.

CAUTION: If the FS/2 is charging on the FS/2 Rack and APM mode is selected, you MUST disable power output, as no additional current is available. If SPM mode is selected, power output is limited to 100mA.

32.1.6 Calculating power usage

To help you calculate power usage and battery life, here are some typical figures for battery usage. The measurements were carried out at 20˚C (68˚F), with a battery terminal voltage of 3.6V and no options fitted other than those shown:

State	Current drawn
OFF (quiescent current)**	0.110mA
ON, in power save mode (idle)	15mA
ON, not in power save mode, with 1MB RAM	120mA
With further 2MB RAM	Plus 15mA
With **Rack** interface active	Plus 75mA
Using serial comms	Plus 60mA
Providing a peripheral with 100mA	Plus 170mA
Backlight on	Plus 35mA

Note: **Add battery self-discharge to this figure.

For further advice on power calculations, contact Husky Computers or your supplier; ask for Husky Technical Note TN 285.

32.2 Using the facilities

32.2.1 Setting up

FS/2 allows you to use a range of power sources and provides a wide range of user and programming facilities related to their use. This section provides a few simple guidelines on setting up units to use either alkaline or NiCad batteries, which should provide a basis for your procedures. You will probably need to modify your procedures in the light of experience.

Switching units from one battery type to the other requires a little more care. This is described in Part 2, and should normally only be undertaken by reliable personnel, typically within your technical support department.

32.2.1.1 Using alkaline batteries

If the users are competent, simply familiarise them with the instructions in Part 2, on changing batteries and using the HOT key and provide them with spare batteries. This approach is preferable since it involves you in the least extra work!

If the unit will be used by non-technical operators exclusively with alkaline batteries, set it up as follows:

- Use the HOT key power option (see Part 2) to:
  - Enable Advanced Power Management
  - Set the power remaining to 100% (if fresh batteries)
  - Set the low power warning onset to 5%
  - Set battery chargeable to No
  - Set battery capacity to 1800mAh (or 80% of the nominal capacity, if quoted by the manufacturer)
  - Set charging authorisation to 1
  - Exit the HOT key.

- Create a simple utility which:
  - Inhibits the HOT key power option (INT 15H function 7CH)
  - Inhibits the battery change power option (INT 15H function 7EH)
- Run the utility on each unit.
- In the application, provide a 'battery change' option (perhaps protected by a password), which resets the power level to 100% (INT 15H function 66H).
- Install the application and give out the units fitted with alkaline batteries (plus spares). **Do not provide AC adaptors or NiCads.**
- Tell users about the low power warnings and how to use the HOT key to check the power level, so they will know when to change the batteries. Tell them how to use the battery change option in the application.

If users do not need to change batteries while away from home base, you need not provide the 'battery change' option or the spare batteries; instead, the user's technical support department could provide all battery changing facilities.

32.2.1.2 Using NiCads

If the users are competent, simply familiarise them with the instructions in Part 2, on recharging batteries and using the HOT key, and provide them with AC adaptors. This approach is preferable since it involves you in the least extra work!

If the units will be used by non-technical operators exclusively with NiCads, set each one up as follows:

- Fully charge the batteries and fit them to the unit.
- Use the HOT key power option (see Part 2) to:
  - Enable Advanced Power Management
  - Set the power remaining to 100%
  - Set the low power warning onset to 5%
  - Set charging authorisation to 3
  - Set battery chargeable to Yes

- Set the battery capacity to between 1000 and 1400mAh (A-size). Or, if the manufacturer quotes a nominal capacity, use 80% of this (or less, if heavy loads are expected).
- Exit the HOT key.

- Create a simple utility which inhibits the HOT key power option (INT 15H function 7CH)
- Run the utility on each unit.
- Install the applications and give out the units fitted with NiCads and provide AC adaptors. **Do not provide Alkaline batteries.**
- Tell users about low power warnings and how to use their application to check the power level, so they will know when to recharge. Make sure they know how to recharge and do so regularly. **Tell users not to remove the battery cap**.

Note: The **FS/2** will also consider that the battery cap has been removed if power is lost by using undercharged batteries, setting the power remaining incorrectly, or overloading the +4.6V output.

If users do not need to recharge batteries while away from home base, you need not provide the AC adaptor; instead, the user's technical support department could provide all battery charging facilities for them. For example, they could recharge all units overnight, at the end of each day.

32.2.2 Using SLOW mode

The slow modes simply reduce the clock speed, saving power but making programs run slower! Their main use is to conserve power when execution speed is not important. For example, when waiting for something to process, or when performing tasks which require very little processing.

For example, suppose that **FS/2** is connected to a modem which does not provide RI and the application needs to store data received via the modem. You cannot simply turn **FS/2** off and wait for RI, as the modem doesn't provide it.

For example, you could use the following code to minimise power consumption:

```
START:
select slow mode 2 (INT 15H, 60H)
LOOP1:
check modem status (INT 14H, 3)
if no DCD goto LOOP1
select normal mode (INT 15H, 60H)
receive and store file
goto START
```

If you can arrange for **FS/2** to turn on when it needs to do some processing, you can conserve even more power by turning off! For example, if you simply need to respond at regular intervals, you can set the RTC alarm for the next time and that will power-up. If the event that requires processing can provide a suitable signal for connecting to the RI input, you can use that to power-up (see INT 14H function 26H).

32.2.3 Charging NiCad batteries

By default, users can authorise charging by using the power option of the HOT key, but you should disable this (INT 15H functions 7CH and 7EH) if you think there is any likelihood that they will fit Alkaline batteries and then attempt to charge them. REMEMBER, ATTEMPTING TO RECHARGE ALKALINE BATTERIES IS HAZARDOUS!

If you do disable the HOT key power option, you will need to provide charging facilities to **someone**. For example, you might perform all recharging yourself, in which case you could write a simple utility which grants temporary access to the HOT key, but not give copies to users.

Another method would be to build recharging facilities into each application or into a separate utility, but protect them by a password, which you only provide to responsible individuals.

32.2.4 Using fast discharge

Use the fast discharge function (INT 15H function 96H) to "exercise" rechargeable batteries, to help avoid the memory effect which reduces their

capacity if repeatedly recharged when not fully discharged. This might be used as the charging option, or the user might have to select it as a separate option.

When the application uses this function to enable fast discharge, the normal sequence of events is as follows:

1 The BIOS saves present power mode and switches to SPM mode

2 The BIOS inhibits charging

3 The BIOS inhibits power save

4 The BIOS forces VCCout1 to On (to enable high power mode)

5 The BIOS switches on the fast discharge circuit

6 The BIOS monitors the low power indicator. (The **FS/2** remains on.)

While fast discharge is in operation, the **FS/2** is turned on and can execute a user application as normal (but see the caution below). The application should monitor the situation and take appropriate actions as described below.

CAUTION: While using fast discharge mode:

- DO NOT switch to APM mode.
- DO NOT switch off VCCout1. (This will cause power loss.)
- DO NOT enable charging in SPM mode.
- DO NOT disconnect the **FS/2** from the power source (AC adaptor or **Rack**). (This will prevent the **FS/2** recharging after ending fast discharge.)

When fast discharge ends, execution continues from step 7 or 8 depending on the cause:

7 The BIOS restores previous the power mode. (If APM, it sets power remaining to 0%)

8 The BIOS switches off the fast discharge circuit

9 The BIOS enables charging

10 The BIOS allows power save

Fast discharge ends when any of the following happens:

- The low power threshold is reached. This is the "normal" end to the cycle. Execution continues from step 7.

  The time to reach the threshold depends on the initial battery capacity and any additional power drains (eg backlight or peripherals powered via VCCout 1 or 2). The total drain will typically be about 500mA.
- The temperature passes outside the fast discharge override range (used to make sure that charging can resume when discharge finishes). Execution continues from step 8, so the application must restore the power mode and set the battery capacity.
- The application switches off fast discharge. This will typically be if there is not time to complete the fast discharge, or the user selects an option to resume charging. Execution continues from step 8, so the application must restore the power mode and set the battery capacity.
- All battery power is lost. Execution continues from step 7.
- The **FS/2** turns off (eg the user presses ⓘ or the application powers down with INT 15H function 68H). Execution continues from step 7.

Note that during fast discharge, the APM power level is NOT maintained, so if execution continues from step 8, the application must set the power level.

The following steps illustrate how fast discharge might be used within a typical application.

- The user selects the fast discharge option or charge option which uses fast discharge, which calls the following subroutine.

DISCHARGE1:

- Check that the unit temperature is within the charging range (INT 15H, function 97H, AL=0). If not, display a prompt and loop, or exit with a warning.

- Check for the presence of the charger by briefly enabling charging (INT 15H function 65H (APM) or 8AH (SPM)) and checking the charging status (INT 15H function 93H). If not present, display a prompt and loop, or exit with a warning.
- Display a warning message saying that fast discharge is being used, the power supply should not be disconnected, and the user should press Esc NOW to cancel fast discharge.
- Wait about 60 seconds for the user to press Esc to cancel. If Esc is pressed, jump to the charging routine (CHARGING2).
- Disable the ⏻ key to prevent the user turning off (INT 15H function 69H).
- Switch on fast discharge (INT 15H, function 96H, AL=0).
- Loop while doing the following:
  - Poll the discharge status (INT 15H, function 96H, AL=2). If completed (AL=0 on return), check:
    - If the unit temperature is outside the discharge temperature range (INT 15H function 97H, AL=0), handle this error situation by jumping to CHARGING1.
    - Otherwise, discharge has completed and charging commenced, so jump to CHARGING2.
  - If the user presses Esc, jump to CHARGING1.
  - Check the time (INT 1AH function 03H). If there is now insufficient time to complete discharge and charging stages, jump to CHARGING1.

CHARGING1: (handle unusual exit from discharge)

- Disable fast discharge (INT 15H function 96H, AL=1).
- Restore the previous power mode (INT 15H function 89H).
- If APM, set the power level to 0% (INT 15H function 66H) and display a message saying level currently unreliable.

CHARGING2: (handle usual exit from discharge)

- Re-enable power key (INT 15H function 69H).
- Handle charging. For example, in APM mode: monitor and display the power level. When it reaches 100%, turn off charging and turn off the **FS/2**. If charging ceases prematurely, sound an alarm and turn off.

HUSKY FS/2

Part 4
Appendices

Appendix A
Specification

Husky Computers reserve the right to alter the specification or conditions of any product or service without prior notice.

A.1 Physical

Construction	Die-cast magnesium alloy.
Finish	Durable, impact- and chemical-resistant textured paint.
Size	237mm x 130mm x 45mm (9.3 ins x 5.1 ins x 1.8 ins) maximum, excluding feet and connectors. 70 mm (2.8 ins) at handgrip.
Weight	Approximately 750 grams (26 oz) in basic configuration. 850 grams (30 oz) including batteries, interface to **Rack**, up to 3MByte of RAM and backstrap.
Sealing	Waterproof against accidental immersion.
Straps	Backstrap. Neck and shoulder strap options.

A.2 Fascia

Screen	240 x 64 pixel full graphics liquid crystal display with keyboard controlled contrast adjustment. Display area: 88.7mm x 29.4mm (3.5 ins x 1.2 ins) nominal.
Backlight	Electroluminescent panel, with keyboard and program control.
Keyboard	Standard keyboard has 55 programmable keys plus the ⏻ (power) key, with separate numeric keypad. One handed operation for numeric data entry. Waterproof, sealed. Custom keyboard overlays and layouts available. Consult Husky computers or your supplier.

A.3 Programming

Operating system	MS-DOS 3.3, ROM based.
Operating system interface	Assembly language access to standard and extended functions, via BIOS/MS-DOS.
Programming language	GWBASIC interpreter, ROM based.
Storage	Operating system and GWBASIC in ROM. Programs and data stored in 'permanent' RAM disk (battery backed), or optionally in Flash EPROM (using the FLASHBAK utility).
Screen handling	ANSI/IBM PC interface, emulating IBM CGA text and graphics modes. The LCD screen forms a window on a larger (CGA-compatible) virtual screen. The window moves automatically and can also be moved by using the keyboard or under program control.
Keyboard	All keys other than ⏻ (power key) reprogrammable in software.
Sound	IBM PC compatible, with mute and volume functions.

A.4 Communications

Port 1	COM1. Full modem interface, via a 12-pin circular connector or standard 9 pin ‘D’ type or 25 pin ‘D’ type connector.
Port 2	COM2. Full modem interface via a 12-pin circular connector or reduced interface via 9 pin ‘D’ type connector or shared 25 pin ‘D’ type connector.
Port 3	Simple serial port, also used to connect the Husky AC charger.
Rack contacts	COM1. Pulse width modulated communications via contacts. (Software selection between Port 1 connector and Rack contacts.)
Configuration	The COM ports provide the usual IBM PC port facilities, but additional facilities may be selected under software control, including:
Baud rate	All ports, 110 to 38,400 Baud asynchronous.
Buffering	Independent 256 byte buffers for Tx and Rx for each port, interrupt-driven for efficiency.
Protocols	XON/XOFF protocol provided as standard for flow control.
Handshaking	RTS, CTS, DTR, DSR, RI, DCD, all selectable by software.

A.5 Screen

Text modes	In text modes, 25 x 40 or 25 x 80 characters on the virtual screen, default 8 x 40 visible at a time in the LCD window (maximum 10 x 60).
	Variable text size, to enhance readability.
Graphics resolution	320 x 200 or 640 x 200 on the virtual screen. 240 x 64 pixels visible at a time in the LCD window.
Graphics text	In graphics modes, six different character sizes provide up to 10 x 60 on the LCD screen.
Graphics commands	Software support for drawing lines, boxes, ellipses, circles and points.
LCD facilities	Automatic scrolling over virtual screen, with keyboard and program control.
	Split screen facility.
	Screen lookup facility.

A.6 Memory

Types	Low power CMOS RAM, CMOS ROM and Flash EPROM.
Retention	Battery support with fixed internal backup.
RAM	Minimum 512 KByte, maximum 4 MByte.
Flash EPROM	128 KByte minimum, including: Husky BIOS Husky utilities Additional Flash EPROM available as option for use as drive D
ROM	512 KByte, including: MS-DOS operating system and utilities GWBASIC interpreter

A.7 Clock/calendar

Type	Software accessible time, day, date.
Accuracy	Typically +/- 2 seconds per day, but adversely affected by extremes of temperature.
Integrity	Non-volatile, battery backed.

A.8 Microprocessor

Type	16 bit V25+ (enhanced 8088).
Clock speed	8 MHz.

A.9 Batteries

Main batteries	Three A-size Nickel Cadmium rechargeable cells or three AA-size Alkaline Manganese cells.
Operating life	Typical operating lifetime of Alkaline Manganese batteries is up to 30 hours. Typical operating lifetime of Nickel Cadmium batteries (ie time between recharges) is 15 hours.
Power monitoring	Advanced Power Management maintains percentage charge remaining, accessible by user or application software. Standard and Advanced Power Management modes both provide automatic power conservation and shut off facilities.
Recharging	NiCads can be recharged in situ using the supplied AC adaptor or the **Husky FS/2 Communications and Charging Rack**. Charging is under software control.
Data retention	Built-in trickle-charged battery guarantees data integrity for at least 7 days at 20˚C (68˚F) when all other power is removed, under normal operating conditions. Reduced at temperature extremes.
CAUTION:	**Do not fit Lithium batteries under any circumstances.**

Appendix B
Operating Environment

B.1 Operating Temperature

The recommended operating temperature is from -30˚C to +60˚C (-22˚F to +140˚F). Below -30˚C (-22˚F) the LCD screen may become damaged. Prolonged exposure to temperatures above 60˚C (+140˚F) may damage the unit. Do not exceed +70˚ (+158˚F).

Recharging should not be performed outside the range 5˚C to 45˚C (41˚F to 104˚F), so outside this range charging is disabled by the BIOS.

Battery capacity and RTC (clock) accuracy are adversely affected by operation or storage at the temperature extremes.

B.2 Humidity

The **FS/2** is designed to operate in conditions of up to 90% relative humidity. It has an internal desiccator and a visual indicator shows any water ingress (by changing from blue to pink).

B.3 Waterproofing and Dustproofing

The **FS/2** is designed to resist the ingress of water and dust, to standard IP67 (BS 5490). Factory pressure testing assures that leaks do not occur and the unit will normally withstand immersion up to 1 metre (39 inches) of water for up to 30 minutes. Immersion characteristics can be impaired by non Husky approved maintenance or modifications, or by impact damage. The commonest cause of failure is a loose battery cap.

The **FS/2** will withstand exposure to rain without ingress of water.

If water is trapped in the keyboard area it may lead to progressive keyboard failure, exhibited by "over sensitive" or "latched on" keys. To avoid this, drain the unit by storing it vertically in a warm place. **FS/2** should recover when dry. Forced drying is not recommended.

If fine dust or liquids (such as coffee) congeal in the keyboard and prove difficult to remove, make sure that the battery cap is secure and then rinse the unit carefully in warm running water.

If water is trapped in the connectors, blow it out when convenient.

B.4 Storage Conditions

If stored, the **FS/2** must be fitted with batteries. For long-term storage it is essential to fit a new set of Alkaline cells, rather than rechargeable NiCad cells, as NiCad cells have a shelf life of 1 to 3 months if not recharged periodically. The permissible storage temperature range is -30˚C to +70˚C (-22˚F to +158˚F) but avoid prolonged periods above +60˚C (+140˚F). As battery life is much shorter at higher temperatures we recommend storage at less than 35˚C (+95˚F). Under these conditions we recommend batteries are replaced at least every 12 months. Data retention is only guaranteed in the range of -30˚C to +60˚C (-22˚F to +140˚F).

A serious risk with long term storage is battery leakage, which can cause very serious damage to the **FS/2**. Use only the highest quality Alkaline or NiCad cells for storage. Ensure that Alkaline batteries are brand new when fitted and NiCads are fully charged.

Battery capacity and RTC (clock) accuracy are adversely affected by operation or storage at the temperature extremes.

B.5 Electromagnetic Compatibility

The **FS/2** is designed to meet EN55022, BS6527, VfG243, FCC Rules Part 15 Subpart J, and European Community EMC directive 89/336/EEC.

B.6 Resistance to Shock, Vibration and Impact

The **FS/2** is designed to withstand the rigours of normal use, including such demanding applications as:

- Field service
- Forestry
- Utility/Meter reading
- Surveying

- Agriculture
- Data collection in the field

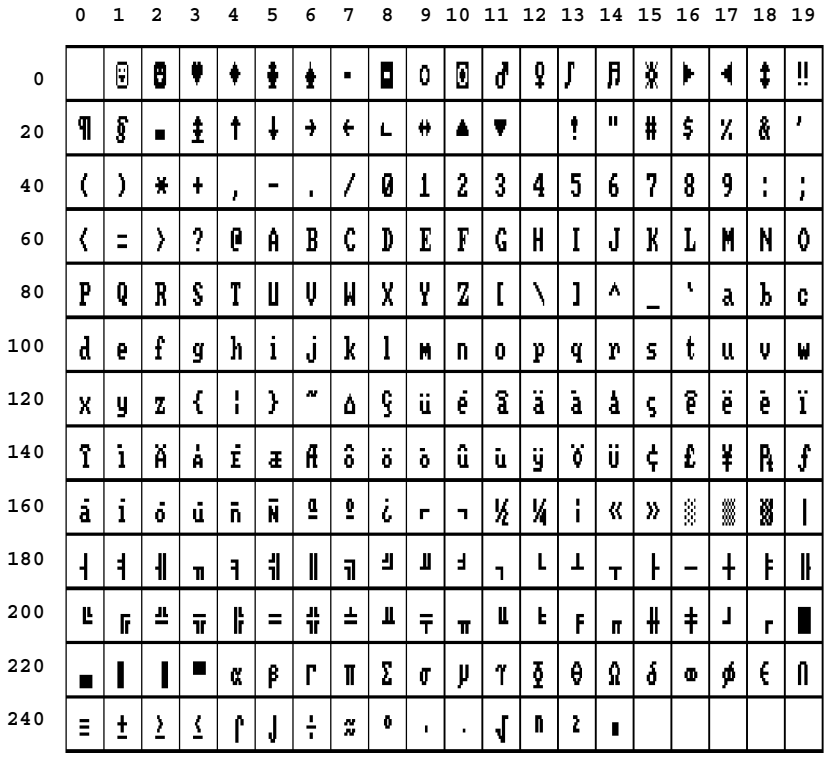
The **FS/2** is designed to withstand shock and accidental drops from up to 2m (6 ft) onto a hard surface and random vibration from shipping or use in wheeled or tracked vehicles. It is recommended that repeated abuse be avoided as far as practical.

B.7 Resistance to Pressure and Elevation

The **FS/2** is designed to resist low pressure levels that would result from shipping in an unpressurised aircraft (equivalent to 15,000 ft; 4,500 m) or operating at high elevations (10,000 ft; 3,000 m).

Appendix C
Character Set

The **FS/2** provides five different character sets, based on grids of 8x6, 8x8, 9x7, 11x8 and 6x4. Each set is based on the extended IBM PC character set and includes all 256 characters (ASCII codes 0 to 255):



Note that ASCII 0 (NUL), 32 (space) and 255 are all blank.

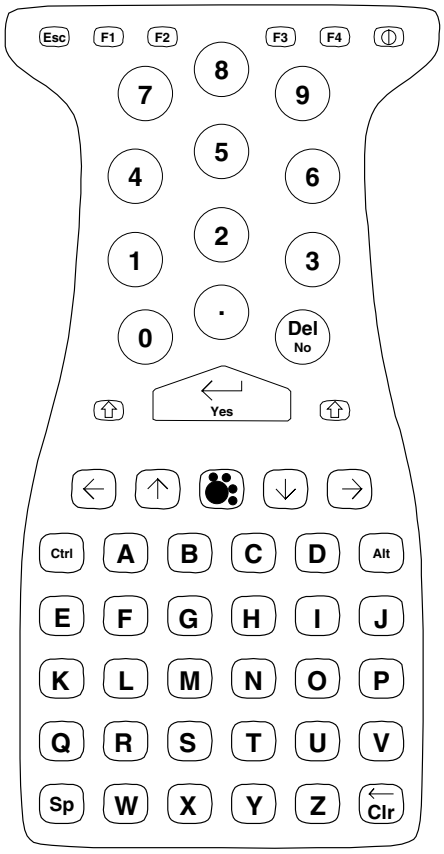
Appendix D
Hexadecimal to Decimal Conversion

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
0	00	32	20	64	40	96	60	128	80	160	A0	192	C0	224	E0
1	01	33	21	65	41	97	61	129	81	161	A1	193	C1	225	E1
2	02	34	22	66	42	98	62	130	82	162	A2	194	C2	226	E2
3	03	35	23	67	43	99	63	131	83	163	A3	195	C3	227	E3
4	04	36	24	68	44	100	64	132	84	164	A4	196	C4	228	E4
5	05	37	25	69	45	101	65	133	85	165	A5	197	C5	229	E5
6	06	38	26	70	46	102	66	134	86	166	A6	198	C6	230	E6
7	07	39	27	71	47	103	67	135	87	167	A7	199	C7	231	E7
8	08	40	28	72	48	104	68	136	88	168	A8	200	C8	232	E8
9	09	41	29	73	49	105	69	137	89	169	A9	201	C9	233	E9
10	0A	42	2A	74	4A	106	6A	138	8A	170	AA	202	CA	234	EA
11	0B	43	2B	75	4B	107	6B	139	8B	171	AB	203	CB	235	EB
12	0C	44	2C	76	4C	108	6C	140	8C	172	AC	204	CC	236	EC
13	0D	45	2D	77	4D	109	6D	141	8D	173	AD	205	CD	237	ED
14	0E	46	2E	78	4E	110	6E	142	8E	174	AE	206	CE	238	EE
15	0F	47	2F	79	4F	111	6F	143	8F	175	AF	207	CF	239	EF
16	10	48	30	80	50	112	70	144	90	176	B0	208	D0	240	F0
17	11	49	31	81	51	113	71	145	91	177	B1	209	D1	241	F1
18	12	50	32	82	52	114	72	146	92	178	B2	210	D2	242	F2
19	13	51	33	83	53	115	73	147	93	179	B3	211	D3	243	F3
20	14	52	34	84	54	116	74	148	94	180	B4	212	D4	244	F4
21	15	53	35	85	55	117	75	149	95	181	B5	213	D5	245	F5
22	16	54	36	86	56	118	76	150	96	182	B6	214	D6	246	F6
23	17	55	37	87	57	119	77	151	97	183	B7	215	D7	247	F7
24	18	56	38	88	58	120	78	152	98	184	B8	216	D8	248	F8
25	19	57	39	89	59	121	79	153	99	185	B9	217	D9	249	F9
26	1A	58	3A	90	5A	122	7A	154	9A	186	BA	218	DA	250	FA
27	1B	59	3B	91	5B	123	7B	155	9B	187	BB	219	DB	251	FB
28	1C	60	3C	92	5C	124	7C	156	9C	188	BC	220	DC	252	FC
29	1D	61	3D	93	5D	125	7D	157	9D	189	BD	221	DD	253	FD
30	1E	62	3E	94	5E	126	7E	158	9E	190	BE	222	DE	254	FE
31	1F	63	3F	95	5F	127	7F	159	9F	191	BF	223	DF	255	FF

Appendix E
Keyboards

E.1 Keyboard layouts

The default (developer) mode looks like this:



This is the keyboard mode provided when the **FS/2** is first unpacked, or after a cold start.

It is mainly intended for initial setting up, program testing, and maintenance work, as it provides easy access to the 🐾, Alt and Ctrl keys.

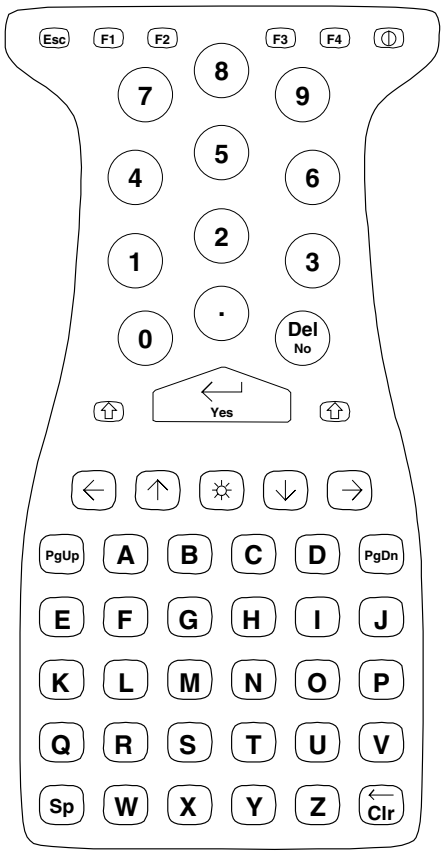
Note that the location of these three keys is indicated by the legends on the keyboard overlay, rather than the key legends.

The standard user mode keyboard looks like this:

This keyboard mode can be selected by using an extended BIOS function or pressing both ⇧ keys plus the key immediately above the ↵ key (shown as ⊙ in the diagram opposite).

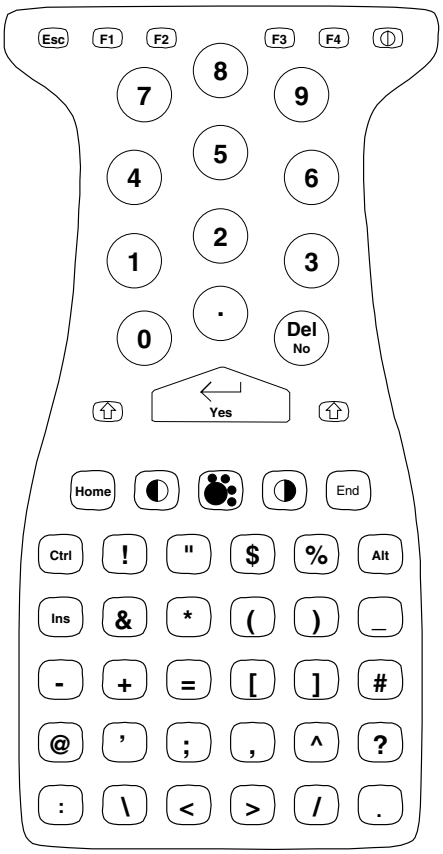
It is mainly intended for users, as it provides easy access to the Backlight, PgUp and PgDn keys (but not PAW, Alt and Ctrl).

Note this keyboard mode is indicated by the legends on the key tops.



This is the developer's mode keyboard when used with either Shift key, with the numeric keypad shift function disabled:

The user keyboard differs in the same three keys as described above.



Applications may however redefine any of the keys by using extended BIOS functions (see Part 3).

E.2 Key matrix codes

The **FS/2** keyboard can be reprogrammed at a low level, by changing the key code assigned to each physical key, using INT 16H function 24H, so you can reprogram any key on the keyboard (other than Ⓕ) to act as any other key. The key matrix codes, which are used to identify the physical keys, are as follows:

Code	Key	Code	Key	Code	Key	Code	Key
0		24		48	5	72	F3
1		25	↓	49	I	73	0
2		26	B	50	O	74	
3		27	G	51	U	75	
4	PgUp*	28	M	52	Z	76	
5	E	29	S	53		77	
6	K	30	X	54		78	7
7	Q	31		55	Del	79	4
8	Sp	32		56	9	80	
9	left ⇧	33		57	2	81	F1
10	right ⇧	34		58	→	82	
11		35	✲*	59	↑	83	Esc
12		36	⟵	60	J	84	1
13	←	37	C	61	P	85	
14	PgDn*	38	H	62	V	86	
15	A	39	N	63	Ctr	87	
16	F	40	T	64		88	Ⓕ
17	L	41	Y	65		89	
18	R	42		66	F4		
19	W	43		67	8		
20		44		68	3		
21		45	6	69			
22		46	⊙	70	F2		
23		47	D	71			

Note: Keys marked with * have other functions in the developer's layout.

E.3 Scan codes

The **FS/2** keyboard provides entirely standard key codes to the key scan routine (INT 9 service routine), which translates them into scan codes. The ASCII part of all scan codes is entirely PC-compatible, but the key token part for some of the shifted key symbols is non-standard.

Note that the special **FS/2** keys (Ⓘ and ❀) and key sequences that are used to control the **FS/2** (such as the HOT key, LCD map and flip keys) generate extra key codes, ie codes which are not generated by keys on an IBM keyboard.

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
01	Esc	011B	ignore	011B	011B	-
02	1	0231	7800	ignore	0221	-
03	2	0332	7900	0300	0340	-
04	3	0433	7A00	ignore	0423	-
05	4	0534	7B00	ignore	0524	-
06	5	0635	7C00	ignore	0625	-
07	6	0736	7D00	071E	075E	-
08	7	0837	7E00	ignore	0826	-
09	8	0938	7F00	ignore	092A	-
0A	9	0A39	8000	ignore	0A28	-
0B	0	0B30	8100	ignore	0B29	-
0C	-	0C2D	8200	0C1F	0C5F	-
0D	=	0D3D	8300	ignore	0D2B	-
0E	Bksp	0E08	ignore	0E7F	0E08	-
0F	Tab	0F09	ignore	ignore	0F00	-
10	Q	1071	1000	1011	1051	-
11	W	1177	1100	1117	1157	-
12	E	1265	1200	1205	1245	-
13	R	1372	1300	1312	1352	-
14	T	1474	1400	1414	1454	-
15	Y	1579	1500	1519	1559	-
16	U	1675	1600	1615	1655	-
17	I	1769	1700	1709	1749	-
18	O	186F	1800	180F	184F	-
19	P	1970	1900	1910	1950	-
1A	[	1A5B	ignore	1A1B	1A7B	-
1B	]	1B5D	ignore	1B1D	1B7D	-
1C	Enter	1C0D	ignore	1C0A	1C0D	-
1D	Ctrl	ignore	ignore	-	ignore	-
1E	A	1E61	1E00	1E01	1E41	-
1F	S	1F73	1F00	1F13	1F53	-
20	D	2064	2000	2004	2044	-

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
21	F	2166	2100	2106	2146	-
22	G	2267	2200	2207	2247	-
23	H	2368	2300	2308	2348	-
24	J	246A	2400	240A	244A	-
25	K	256B	2500	250B	254B	-
26	L	266C	2600	260C	264C	-
27	;	273B	ignore	ignore	273A	-
28	'	2827	ignore	ignore	2822	-
29	#	2960	ignore	ignore	297E	-
2A	Left ⇧	ignore	ignore	ignore	-	-
2B	\	2B5C	ignore	2B1C	2B7C	-
2C	Z	2C7A	2C00	2C1A	2C5A	-
2D	X	2D78	2D00	2D18	2D58	-
2E	C	2E63	2E00	2E03	2E43	-
2F	V	2F76	2F00	2F16	2F56	-
30	B	3062	3000	3002	3042	-
31	N	316E	3100	310E	314E	-
32	M	326D	3200	320D	324D	-
33	,	332C	ignore	ignore	333C	-
34	.	342E	ignore	ignore	343E	-
35	/	352F	ignore	ignore	353F	-
36	Right ⇧	ignore	ignore	ignore	-	-
37	Prtsc	372A	ignore	7200	Print	-
38	Alt	ignore	ignore	-	ignore	-
39	Space Bar	3920	3920	3920	3920	-
3A	Caps Lock	ignore	ignore	ignore	ignore	-
3B	F1	3B00	6800	5E00	5400	-
3C	F2	3C00	6900	5F00	5500	-
3D	F3	3D00	6A00	6000	5600	-
3E	F4	3E00	6B00	6100	5700	-
3F	F5	3F00	6C00	6200	5800	-
40	F6	4000	6D00	6300	5900	-

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
41	F7	4100	6E00	6400	5A00	-
42	F8	4200	6F00	6500	5B00	-
43	F9	4300	7000	6600	5C00	-
44	F10	4400	7100	6700	5D00	-
45	Num Lock	ignore	ignore	Pause	ignore	-
46	Scrl Lock	ignore	ignore	(Break)	ignore	-
47	Keypad 7/Home	4700	ignore	7700	-	4737
48	Keypad 8	4800	ignore	ignore	-	4838
49	Keypad 9/PgUp	4900	ignore	8400	-	4939
4A	Keypad -	4A2D	ignore	ignore	-	4A2D
4B	Keypad 4	4B00	ignore	7300	-	4B34
4C	Keypad 5	ignore	ignore	ignore	-	4C35
4D	Keypad 6	4D00	ignore	7400	-	4D36
4E	Keypad +	4E2B	ignore	ignore	-	4E2B
4F	Keypad 1/End	4F00	ignore	7500	-	4F31
50	Keypad 2	5000	ignore	ignore	-	5032
51	Keypad 3/PgDn	5100	ignore	7600	-	5133
52	Keypad 0/Ins	5200	ignore	ignore	-	5230
53	Keypad ./Del	5300	ignore	ignore	-	532E
54 ..7F	Undefined	ignore	ignore	ignore	ignore	ignore

Key tokens described as ‘ignore’ are actually returned with bit 7 set, which causes them to be ignored.

The following key codes are non-standard. They can be used in INT 16H function 24H, to reprogram the extra **FS/2** keys and reprogram keys to perform non-standard actions:

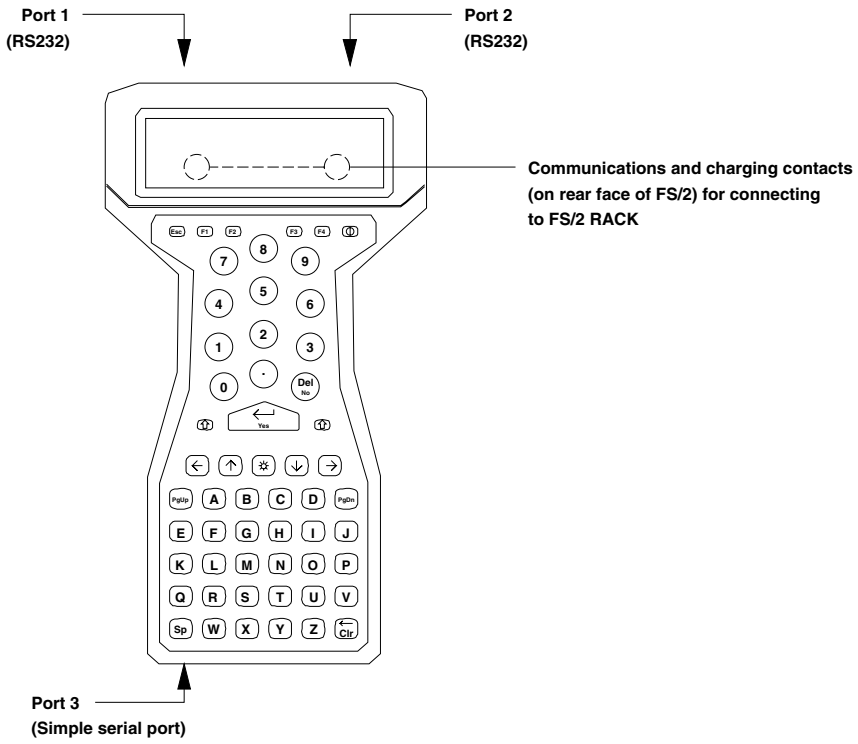
Key Code	Key Action
B1	F10 (🐾 0)
B2	F9 (🐾 9)
B3	F8 (🐾 8)
B4	F7 (🐾 7)
B5	F6 (🐾 6)
B6	F5 (🐾 5)
B7	F4 (🐾 4)
B8	F3 (🐾 3)
B9	F2 (🐾 2)
BA	F1 (🐾 1)
BB	Reserved
BC	Reserved
BD	]
BE	[
BF	Scroll lock (🐾 Esc)
C0	Print screen (🐾 P)
C1	Undefined
..E6	
E7	Reserved
E8	Increase contrast with wraparound (see below)**
E9	Reserved
EA	Reserved
EB	Reserved
EC	Reserved
ED	Momentary SHIFT (shift next key)
EE	HOT key (🐾 H)
EF	Toggle sound (🐾 S)

**When the contrast reaches maximum, this key will start again from minimum contrast.

Key Code	Key Action
F0	Toggle MAP mode (🐾 Ⓜ)
F1	Reserved
F2	Flip window (🐾 Ⓕ)
F3	Shift window right (🐾→)
F4	Shift window left (🐾←)
F5	Shift window down (🐾↓)
F6	Shift window up (🐾↑)
F7	Reserved
F8	Toggle backlight (🐾 Ⓛ)
F9	Reserved
FA	Reserved
FB	Decrease contrast (🐾 Ⓧ)
FC	Increase contrast (🐾 Ⓔ)
FD	Ⓘ
FE	🐾
FF	No action ie ignore key

Appendix F
Interfacing

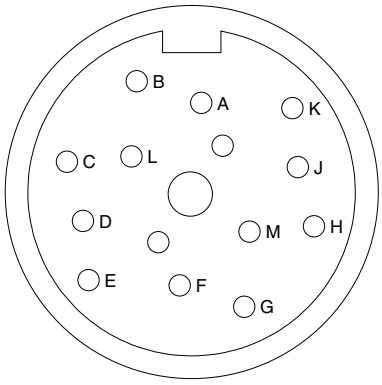
The **FS/2** may be fitted with up to four separate connectors for interfacing:



Note that depending on the version of **FS/2**, different connectors will be installed.

F.1 12-way connectors (Port 1 and Port 2)

If fitted, the 12-way connectors provide access to the main and secondary serial ports, Port 1 and Port 2:



(as seen from outside the **FS/2**)

The pinouts are as follows:

Pin	Description	Pin	Description
A	Ring Indicator	G	Signal Ground
B	Transmitted Data	H	Data Carrier Detect
C	Received Data	J	Data Terminal Ready
D	Request to Send	K	+4.6V Power Out
E	Clear to Send	L	Charger Input (2)
F	Data Set Ready	M	Not connected

Note that pin L is used on Port 2 only.

The electrical specification of this interface is in accordance with EIA specification RS232C.

The output voltage levels are software selectable between Logic and RS232 levels (see Part 3). However, if COM1 output is redirected from Port 1 (see Part 3), only logic level is available for Port 2.

Outputs	Logic levels	RS232 levels
Logic 0: Logic 1:	> +2.5V < +0.3V	> +5.0V < -5.0V

Absolute maximum voltage inputs +/- 25V.

Inputs	Logic levels	RS232 levels
Logic 0: Logic 1:	+2.5V maximum +0.5V minimum	+3.0V maximum -3.0V minimum

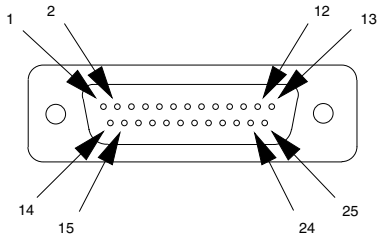
Input pins present an impedance of between 3 and 7 Kohm.

The +4.6V outputs are independently programmable (see Part 3). When set to OFF, they are open circuit. When set to ON, they provide a nominal +4.6V at up to 400mA (total), with a programmable soft-start (to minimise the initial load on the **FS/2** power supply). The voltage available varies with load:

External Load	Output Voltage
100 mA 400 mA	> 4.5V > 4.0V

F.2 25-way D type (Port 1 and Port 2)

If fitted, the 25-way D type socket provides access to the main and secondary serial ports, Port 1 and Port 2.

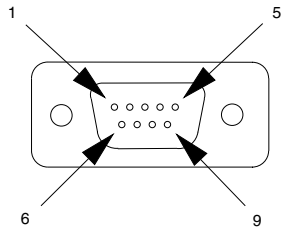


Pin	Description	Pin	Description
1	Protective Ground	14	Transmitted Data (2)
2	Transmitted Data	15	Not connected
3	Received Data	16	Received Data (2)
4	Request to Send	17	Not connected
5	Clear to Send	18	Not connected
6	Data Set Ready	19	Request to Send (2)
7	Signal Ground	20	Data Terminal Ready
8	Data Carrier Detect	21	Not connected
9	+4.6V out (2)	22	Ring Indicator
10	+4.6V out	23	Not connected
11	Data Set Ready (2)	24	Not connected
12	Data Carrier Detect (2)	25	Charger In
13	Clear to Send (2)		

For electrical details, see the description of the 12-way connectors. Signals with a (2) are for Port 2.

F.3 9-way D types (Port 1 and Port 2)

If fitted, the 9-way D type connectors provide access to the main and secondary serial ports, Port 1 and Port 2. The pinouts are as follows:



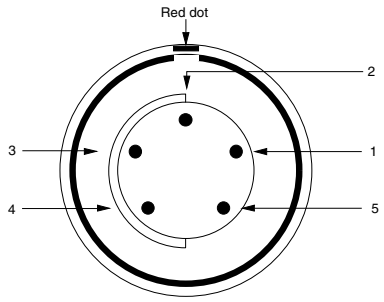
Pin	Description	Pin	Description
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator (Port 1)
5	Signal Ground	9	+4.6V Out (Port 2)

For electrical details, see the description of the 12-way connectors.

F.4 5-way FISCHER (AC adaptor)

This socket is fitted to all variants of the **FS/2** and can be used to connect a simple serial device or the **FS/2 AC adaptor**.

Note: The only AC adaptor that you should use is the **FS/2 AC adaptor** with a 5-way FISCHER plug.



Pin	Description
1	Charger Input
2	Received Data
3	Clear To Send/4.6V output
4	Transmitted Data
5	Ground

Pin 1 is used for connecting a Husky approved AC adaptor or vehicle cable. The **FS/2** draws a maximum of 1.2A, but nominally 220mA (SPM) or 440mA (APM). Pin 3 provides +4.6V out in parallel with the +4.6V output of Port 2, when output is enabled (see Part 3).

If COM1 is redirected from Port 1 (see Part 3), CTS input on pin 3 is inoperative and Logic levels only are supported for pins 2 and 4, but the +4.6V output operates as normal.

All data input pins present an impedance of 3 to 7 Kohm. Pin 2 and 4 handle RS232 levels as described for the 12-way connectors. When used as a CTS input, the maximum voltage levels allowed on pin 3 are as follows:

Pin 3	Maximum levels
Logic 0: Logic 1:	+5.25V -1.5V

F.5 Modem option (COM1)

If the internal modem option is fitted, a connector is fitted to connect to the phone line.

To use the modem option, the **FS/2** must switch to MODEM communications mode (see Part 3) and then use COM1 for I/O. In this mode, Ports 2 and 3 are limited to Logic levels and Port 3 CTS input does not operate.

For details of the modem and its use, refer to the documentation supplied with the internal modem option.

F.6 Communications and charging contacts (COM1)

The communications and charging contacts are fitted to all variants of the **FS/2**, to provide a quick and easy connection to the Husky **FS/2 Communications and Charging Rack** for charging.

To use the contacts for communications, the **FS/2** must be fitted with the **Communications Via Charging** option. To use this, the **FS/2** must switch to RACK communications mode (see Part 3) and then use COM1 for I/O. In this mode, Ports 2 and 3 are limited to Logic levels and Port 3 CTS input does not operate.

While charging on the Rack with APM mode selected, no additional current is available for powering external peripherals. If SPM is selected, power output is limited to 100mA.

For full information on communications via these contacts, see the *FS/2 Communications and Charging Rack System Developer's Guide*.

Appendix G BIOS Revisions

This appendix briefly summarises the main changes in major releases of the **FS/2** BIOS. The BIOS version number is displayed when **FS/2** boots, after the Welcome screen.

G.1 Version 1.0

Original production release of BIOS.

G.2 Version 1.10

Summary:

- RAM disk structure changed to provide the option of additional stability during a program crash, at the expense of free memory. (See the description of the Format fixed disk option of UTIL in Part 2.)
- Minor changes to the HOT key, eg idle timeout increments in 2 minute steps rather than 1 minute steps.
- New utilities: I.COM (international keyboard definition) and HCOM.COM (file transfer).

BIOS functions:

- INT 15H function 91H: deleted
- INT 15H function 92H: deleted
- INT 15H function 94H: documented (reset machine information)
- INT 15H function 95H: documented (get machine information)
- INT 15H function 96H: new (fast discharge)
- INT 15H function 97H: new (fast discharge temp override)

(See the BIOS description in Part 3 for further information on these functions.)

G.3 Version 1.20

Summary:

- Support for an additional 11x8 text font

- Bold version of the 6x8 font
- Unit's actual serial number now stored in EPROM
- Facility to disable the Welcome screen
- Facility to override CONFIG.SYS and AUTOEXEC.BAT while booting
- COM1 input buffer and polling to improve data reception
- Facility to disable 8250 emulation to improve performance of interrupt-driven comms packages
- New XL.COM utility, an XMODEM downloader
- EDIT.COM no longer supplied in the **FS/2** EPROM, but available on diskette

BIOS functions:

- INT 10H function 60H: revised to support bold font
- INT 10H function 73H: revised to support 11x8 font
- INT 10H function 7BH: new (attribute mask for bold)
- INT 14H function 33H: new (control COM1 input buffering)
- INT 14H function 34H: new (control 8250 emulation)
- INT 15H function 98H: new (use custom font data)
- INT 15H function 99H: new (get BIOS serial number)
- INT 15H function 9AH: new (get customer id)
- INT 15H function 9BH: new (resync timer with RTC)

(See the BIOS description in Part 3 for further information on these functions.)

For more details, also see Husky Technical Note 301.

Appendix H The Husky Oracle GT

This appendix describes operation of the Husky Oracle GT external diskette drive with the **FS/2**. This product is no longer available.

H.1 Introduction

The **Husky Oracle GT** is a portable external diskette drive which can read from and write to 3.5" IBM-compatible diskettes. It is usually fitted with a connector suitable for Port 3 (the 5-way Fischer).

Set the disk drive Baud rate to 38,400 for use with **FS/2** and connect it to Port 3. The drive will be recognised automatically (as drive A) the next time you reboot the **FS/2**.

With the appropriate connector you can connect the disk drive to Port 2, when it will normally be accessed as drive B. (Although an application may swap these drive letters by using INT 15H function 84H, described below.)

H.2 Formatting diskettes

You must format diskettes before you can use them. You can format diskettes on a PC using the standard MS-DOS FORMAT command, or use the UTIL utility to format them in the **Oracle GT** drive. However, to prepare a system (bootable) diskette, you MUST use UTIL.

Select the **`Format Diskette`** option from the UTIL menu and you will see a screen like this:

Check that the format is as you want it ie the diskette is suitable for the density and whether you want to make the diskette bootable. When you are ready to format the diskette, press ⏎ and the following screen will be displayed:

Press any key to begin formatting, or Esc to return to the main menu.

CAUTION: Formatting destroys any information already on the specified disk.

When the disk has been formatted, you are returned to the same screen. To format another diskette, simply press ⏎ again.

H.3 Rebooting with the Oracle GT

If you reboot with a diskette inserted in the **Oracle GT**, **FS/2** will attempt to reboot from it. To boot from drive C, simply remove the diskette before rebooting.

If you want to boot from a diskette, it must have been formatted by using the UTIL utility's **`Format Diskette`** option, with the **`Write system files`** option set to Yes.

H.4 Recovering from drive C corruption with the Oracle GT

If you see this message when the **FS/2** reboots:

```
Verify failed sector: xx
Potential data corruption detected
Please contact your system provider
```

Then the RAM disk is corrupted. With an **Oracle GT** diskette drive connected, the best way to recover is to insert an **FS/2** system disk and reboot. This will allow you to use the **FS/2** and recover files from the RAM disk by copying them to diskette. You can then reformat the RAM disk by using UTIL. Check any recovered files; they may be corrupted too.

If this does not work, use one of the other recovery methods described in Part 2.

H.5 Loading applications with the Oracle GT

With the **Oracle GT**, you may find it quicker or easier to install an applications direct from diskette onto the RAM disk, rather than by installing onto a PC and then using communications to transfer it to the **FS/2**. While you may be able to run an application from diskette, the RAM disk is much faster and more convenient.

H.6 Programming the Oracle GT

The **Oracle GT** is used much like a conventional diskette drive, but there are a number of additional facilities and a few limitations, described in this section. These affect INT 13H, 15H and 19H.

H.6.1 INT 13H

This is the main disk services interrupt. With the **Oracle GT** fitted, you have access to these diskette services:

Function	Description	Drive A/B
00H	Reset disk system	yes
01H	Get disk status	yes
02H	Read disk sectors	yes
03H	Write disk sectors	yes
04H	Verify disk sectors	yes
05H	Format track	yes (whole disk)

06H	Format with bad sectors	BAD
07H	Format drive	BAD
08H	Get drive parameters	yes
09H	Initialise base tables	BAD
0AH	Read long	BAD
0BH	Write long	BAD
0CH	Seek to cylinder	BAD
0DH	Alternate reset	BAD
0EH	n/a	BAD
0FH	n/a	BAD
10H	Test drive ready	BAD
11H	Recalibrate drive	BAD
12H	n/a	BAD
13H	n/a	BAD
14H	Controller diagnostics	NO
15H	Get disk type	yes
16H	change diskette	yes
17H	n/a	NO
18H	set media type	yes
19H	reserved	yes

Functions described as NO are not implemented but will return with the status set to 0 (operation successful). Functions described as BAD are not implemented and will return with the status set to 1 (bad command). Functions described as W/P will return with status set to 3 (write failed to write-protected disk).

The drive numbers for the **Oracle GT** are 0 (A) and 1 (B).

The remainder of this section describes the differences when accessing the **Oracle GT**; for more details of the functions, see the INT 13H description in Part 3.

Function 00 - Reset disks

Description Resets the **Oracle GT** drive(s).

Function 02 - Read sectors

Entry
AH=02H
AL=no. of sectors
BX=offset of read data buffer
ES=segment of read data buffer
DH=head no.
DL=drive no.
CH=track no.
CL=sector no.

Description
Reads the specified sectors to the buffer, which must all be on the same track.

Function 03 - Write sectors

Entry
AH=03H
AL=no. of sectors
BX=offset of write data buffer
ES=segment of write data buffer
DH=head no.
DL=drive no.
CH=track no.
CL=sector no.

Function 04 - Verify sectors

Entry
AH=04H
AL=no. of sectors
DH=head no.
DL=drive no.
CH=track no.
CL=sector no.

Function 05 - Format track

Entry
AH=05H
DH=0
CH=0
(other registers ignored)

DH and CH must both be 0 to format the whole diskette; any other register values will mean that the function is ignored.

Function 15H - Get disk type

Description Gets the drive type in AH:
1=diskette without change detection
2=diskette with change detection

Function 16H - Change diskette status

Entry AH=16H

Exit AH=disk status
DL=drive with disk change

Description Checks to see if the disk has been changed in any diskette drive. If it has, AH=06H and DL=drive id. If it has not, AH=00H.

Function 18H - Set media type

Entry AH=18H
AL=disk type

Exit

Description Sets the diskette type according to AL:
0=no disk
1=regular diskette in regular drive
3=high capacity diskette in high capacity drive

H.6.2 INT 15H

With the **Oracle GT** fitted, you have access to two additional services:

73H Get **Oracle GT** power level
84H Get/set diskette port

Function 73H - Get Oracle GT power level

Entry AH=73H
AL=drive (0 is A:, 1 is B:)

Exit

If AH=0 then AL=level:
25 decimal = 25%
50 decimal = 50%
75 decimal = 75%
100 decimal = 100%
If AH=FFH then drive is not connected

Description

Use this function to read the power remaining in the drive's batteries, as a percentage of their total power.

Function 84H - Get/set diskette port

Entry

AH=84H
AL=0 (get) or non 0 (set)
BH=drive (0=A:, 1=B:)
BL=port (0=port 3, 1=COM2), if set

Exit

AL=port, if get

Description

Use this function to define which port to use for which diskette drive, or to read the current port assignment for the specified drive.

The default state is for drive A to be addressed as port 3 and drive B to be addressed as COM2.

H.6.3 INT 19H

With a diskette inserted in the **Oracle GT**, INT 19H attempts to reboot MS-DOS from sector 1, track 0 of the diskette. If this fails (due to a missing disk or disk drive), it reboots using sector 1, track 0 of the RAM disk (drive C). If this fails, the user is asked to insert a system disk.

If you want to boot from a diskette, it must have been formatted by using the UTIL utility's **`Format Diskette`** option, with the **`Write system files`** option set to Yes.

Index

12-way connectors, 375

25-way D type, 378

5-way FISCHER, 380

6845 emulation, 313

8237 emulation, 328
8250 emulation, 321
  buffering, 322
  disabling, 241
  divisor latch, 323
  interrupt enable register, 323
  interrupt id register, 324
  limitations, 322
  line control register, 324
  line status register, 327
  modem control register, 326
  modem status register, 326
8253 emulation, 319
8255 emulation, 317
8259 emulation, 329
  initialisation command words, 329
  operation command words, 330
  status words, 331

9-way D type, 379

AC adaptor
  connecting, 46
  connector, 380
  using to charge NiCads, 45
  using to power the FS/2, 57
Accessories
  see ‘Expansion’
Adapting applications
  assembly language routines, 180
  BASIC applications, 179
  fine tuning, 179
  Hunter 16 applications, 181
  MS-DOS applications, 179
  PC-DOS applications, 179
Adjusting the LCD, 27
Alkaline batteries
  see ‘Batteries’
APM mode, 17, 58, 89
  also see ‘Power handling subsystem’
Applications, adapting
  see ‘Adapting applications’
Applications, installing
  see ‘Installing applications’
ASCII character set, 363
AUTOEXEC.BAT
  contents of, 18, 174
  disabling, 69
Automatic power off, 59, 88
Autorepeat, 88
Auxiliary serial port
  see ‘Port 2’

Backlight
  timeout, 88
  using, 28
Backup battery
  battery life, 44
  charging, 58
  purpose, 48
Bar code input, 166
Batteries
  also see ‘Power’
  - introduction, 43
  backup battery, 16, 44
  battery life - alkalines, 52
  battery life - backup, 44
  battery life - NiCads, 45, 48, 50
  calculating battery life, 343
  changing batteries, 53
  changing to Alkalines, 50
  changing to NiCads, 54
  disposing of batteries, 43
  fast discharge, 48, 340
  main batteries, 15
  maximising battery life - NiCads, 48
  memory effect, 48
  monitoring, 17, 58
  recharging, 45
  recycling batteries, 43
  self-discharge - NiCads, 45, 58

setting battery type, 90
setting power remaining, 90
shelf life - alkalines, 52
shelf life - NiCads, 45
temperature effects, 44, 45, 48, 52
using Alkaline batteries, 51
using NiCads, 44
when to change, 52
when to recharge, 45
Battery backup, 16, 58
BIOS extension functions interrupt (15H), 243
acknowledge event, 255
authorise charging, 248
control battery change facilities, 262
control charging in SPM, 270
control fast discharge, 275
control HOT key, 260
control HOT key power option, 261
control power down, 251
control power menu, 267
control power output, 264
control power save, 258
control Resume mode, 247
control screen synchronisation, 266
control SLOW mode, 252
control sound, 256
control STOP mode, 250
enable/trap event, 254
get battery type, 263
get boost charge setting, 272
get charging status, 273
get charging temperature override, 270
get customer id, 278
get DOS RAM, 259
get event details, 253
get fast discharge status, 275
get fast discharge temperature override, 275
get idle timeout, 247
get machine information, 274
get power-up keys, 269
get power level, 246
get power mode, 269
get power save entry flag, 271
get ROM BIOS version number, 252
get screen attribute table, 267
get serial number, 252
get unit serial number, 277
get volume level, 273
invoke HOT key, 260
override low power turn off, 261
power down, 251
power up keys, 256
redirect LPT1, 260
redirect serial number, 257
reset machine information, 274
resynchronise system clock, 278
revector INT 72H, 268
select soft font, 276
set backlight power up state, 258
set battery capacity, 263
set battery level, 250
set battery type, 263
set boost charge setting, 272
set charging temperature override, 270
set clock speed, 246
set contrast power up state, 258
set DOS RAM, 259
set fast discharge temperature override, 275
set idle timeout, 247
set low power threshold, 246
set power mode, 269
set power out mark/space duration, 273
set power save entry flag, 271
set screen attribute table, 267
set volume level, 273
sound output, 265
BIOS interrupts, 183
INT 05H, 189
INT 10H, 191
INT 11H, 211
INT 12H, 213
INT 13H, 215
INT 14H, 221
INT 15H, 243
INT 16H, 280
INT 17H, 293
INT 19H, 295
INT 1AH, 297
BIOS revisions, 383
BIOS upgrades, 165

Booting, 16, 20, 25
  and the system files, 18
  disabling system files, 69
Break key, 35, 37
British Summer Time (BST), 79
Buffering communications, 124

Case
  cleaning, 41
  construction, 353
  resistance to pressure, 362
  sealing, 42, 360
CGA compatibility, 27
CGA emulation
  also see '6845 emulation'
  character set, 316
  colour select register, 315
  display RAM, 313
  lightpen register, 315
  mode control register, 314
  status register, 315
Changing alkaline batteries, 52, 53
Changing NiCads, 48, 50
Character set, 316, 363
Charging authorisation, 47, 60
  displaying, 86
  setting, 90
Charging batteries
  see 'Recharging batteries'
Check memory size interrupt (12H), 213
Check system equipment interrupt (11H), 211
Cleaning
  the case, 41
  the keyboard, 66
  the LCD, 26, 28, 41
Clock
  accuracy, 358
  and British Summer Time, 79
  and Daylight Saving, 79
  and leap years, 79
  problems with, 73
  setting for the first time, 16
  setting the date, 79
  setting the time, 78
  temperature effects, 360
Clock handler interrupt (1AH), 297
  disable RTC alarm, 300
  get RTC alarm time, 300
  get RTC date, 299
  get RTC time, 298
  get system clock, 298
  set RTC alarm, 300
  set RTC date, 299
  set RTC time, 299
  set system clock, 298
  set system clock source, 301
Cold start, 16, 183, 186
Colour graphics adaptor
  see 'CGA', 'LCD' and 'Screen'
Colours on the LCD, 30
COM utility, 152
COM1
  see 'Port 1'
COM2
  see 'Port 2'
COMMAND.COM, 36, 175
Communicating with
  a modem, 143
  an IBM PC, 161
  another FS/2, 141, 160
  Hunter 16, 142, 160
  IBM personal computers, 144
  serial printers, 147
Communications
  - introduction, 121
  - introduction to using, 149
  and interface power, 150
  background information, 124
  buffering, 124
  communications packages, 123
  configuring Husky communications
    see 'Communications configuration'
  configuring IBM communications, 140
  connecting to COM1 and COM2, 125
  errors, 162
  FS/2 communications - configuring
    see 'Communications configuration'
  FS/2 communications - description, 123
  FS/2 communications - selecting, 81, 126
  handshaking, 127

IBM communications - configuring, 140
IBM communications - selecting, 81
MODE command, 141
pinouts, 378
ports, 122, 378
selecting the mode, 81
starting communication, 150
using FS/2 applications, 159
using MS-DOS applications, 159
using MS-DOS comms packages, 159
using the standard facilities, 150
Communications and charging contacts, 14, 381
Communications and charging rack
and communications, 122
and the HCOM utility, 155
as a power source, 43
contacts, 14
Communications configuration, 81, 126
CTS, 131
DCD, 131
DSR, 132
DTR, 132
ECHO, 133
FS2 MODE, 133
LENGTH, 133
LF, 134
NULL, 135
PARITY, 135
PROTOCOL, 136
RTS, 137
RX T/O, 138
SERIG, 138
SPEED, 139
STOP, 139
TX T/O, 140
Communications protocols
- introduction, 128
HWK3780 option, 130
NONE, 129
options, 130
XON/XOFF, 129
CONFIG.SYS
contents of, 18, 174
disabling, 69
Configuring
applications, 173
backlight timeout, 88
calendar, 79
clock, 78
drive C, 79
FS/2 communications, 81, 126
IBM communications, 140
idle timeout, 88
keyboard, 87
memory usage, 79
MS-DOS, 18
operation, 17
power, 89
screen, 86
Connectors
- introduction, 375
12-way (ports 1 & 2), 375
25-way (ports 1 & 2), 378
5-way FISCHER (AC adaptor), 380
9-way (ports 1 & 2), 379
Contrast, 27
Controlling
charging, 90
low power handling, 90
power handling, 89
sound level, 36
the keyboard, 87
the LCD, 27, 86
Conventions, 8
Copy protection, 170
Ctrl Alt Del, 25
Ctrl Break, 35
Cursor visibility, 87
Customer id, 278
Customer support, 1

D-type
see ‘Port 1’
Date
displaying, 86
setting, 79
Daylight Saving Time, 79
Decimal to Hexadecimal, 364
Deep discharge, 48, 340
Developer keyboard, 32, 365
Device emulations, 312
6845, 313

8237, 328
8250, 321
8253, 319
8255, 317
8259, 329
FDC, 332
HDC, 332
Dimensions, 353
Disk handler interrupt (13H), 215
format track, 219
get disk type, 220
read drive parameters, 220
read sectors, 217
reset disk status, 217
reset disks, 217
verify sectors, 218
write sectors, 218
Diskette controller, 332
Display
see 'CGA', 'LCD' and 'Screen'
Display RAM, 313
Disposing of batteries, 43
DMA controller, 328
Drive C
checking for problems, 74
displaying free space, 36, 86
formatting, 79
system files, 18
Drive D
displaying free space, 36, 86
using, 165
writing to, 165, 170
Dustproofing, 42

EDIT
- introduction, 91
and CR, 92
and TAB characters, 93
browse mode, 93
case sensitivity, 92
changing option settings, 112
command keys, 98, 99
command options, 92
control keys, 98
default path, 91
error messages, 118
facilities summary, 96
file format, 91
file handling, 91
file size, 92
function keys, 99
insert mode, 94, 96, 104
keys, 98, 99
line end character, 92
line end indicators, 95
line wrapping, 92
overtype mode, 94, 96, 104
screen layout, 93
special keys, 100
text font, 93
typing modes, 94, 96, 104
EDIT commands
- summary, 96
BLOCK COPY, 101
BLOCK DELETE, 101
BLOCK END, 102
BLOCK MOVE, 102
BLOCK START, 102
BLOCK WRITE, 103
CHARACTER INSERT, 104
CURSOR KEYS, 105
DELETE FILE, 105
DELETE LEFT, 106
DELETE RIGHT, 106
DIRECTORY, 106
error messages, 118
EXIT, 107
FILE END, 107
FILE START, 107
FIND, 108
keys, 98, 99
LINE DELETE, 109
LINE END, 109
LINE START, 109
PAGE DOWN, 109
PAGE UP, 109
PRINT SCREEN, 110
READ FILE, 110
REPLACE, 111
SAVE, 112
SET, 112
TAB, 114
UNDELETE, 115
VIEW FILE, 115
WORD DELETE, 116
WORD SKIP, 116

EDIT options
60, 93
BROWSE, 93
IGNORE, 92
KEY, 93
LF, 92
TAB, 93
WRAP, 92
Electromagnetic compatibility, 361
EMC legislation, 39, 361
Error messages
communications, 162
EDIT, 118
general, 66
when booting, 70
Expansion, 64
bar code input, 166
memory, 165
meter reading probes, 166
power sources, 164
software upgrades, 165

Fast discharge, 48, 340
File transfer utilities, 152, 154, 155
FISCHER socket
see 'Port 2'
Fixed disk
see 'Drive C'
Fixed disk controller, 332
FLASH EPROM
see 'Drive D'
and the BIOS, 358
FLASHBAK utility, 16, 58, 165, 170
Flip screen key, 28
Foreign keyboard support, 19
FORMAT command, 81
Formatting drive C, 79
FS/2 communications
advantages, 123
configuring
see 'Communications configuration'
selecting, 81
Function keys, 35
FXPREP command, 81

Guarantee, 64
GWBASIC applications, 180

Handstrap, 14, 61
removing, 61
replacing, 63
Hardware
- introduction, 303
device emulations, 312
also see individual devices
I/O addresses, 306
interrupts, 183, 311
logical memory, 305
memory maps, 304
physical memory, 306
Hardware interrupts, 183
HCOM utility, 154
and the communications and charging rack, 155
Hexadecimal to Decimal, 364
HOT key, 36, 85
- introduction, 85
autorepeat, 88
inverse video, 87
keyboard option, 87
power option, 89
screen option, 86
screen synchronisation, 87
split screen, 87
status information, 86
text font, 86
turn off timeout, 88
using, 85
Humidity indicator, 41
Hunter BASIC applications, 180
Hunter 16 applications, 181
Husky communications
see 'FS/2 communications'
Husky Portable BASIC applications, 180

I.COM, 19
I/O address decoding, 306
IBM BASIC applications, 180
IBM communications
configuring, 140
selecting, 81
IBM compatibility, 27, 169, 183, 47
Idle timeout, 60
Installing applications
- introduction, 169

compatibility, 169
configuring the application, 173
copy protection, 170
copying files, 172
operating system, 175
special considerations, 176
testing, 175
Interfaces
see 'Sockets'
International keyboard support, 19
Interrupt controller
see '8259 emulation'
Interrupts
- introduction, 183
- summary, 184
and HALT mode, 341
and STOP mode, 341
BIOS, 186
handling, 330
hardware interrupts, 183, 311
interrupt controller, 329
masking, 330
microprocessor interrupts, 183
priorities, 329
serial interrupts, 321, 323, 324, 71
types, 183
vectors, 183
Introduction to
adapting applications, 179
batteries, 43
communications, 121
communications protocols, 128
device emulations, 312
EDIT, 91
FS/2, 1
handshaking, 127
hardware, 303
HOT key, 85
installing applications, 169
interrupts, 183
keyboard, 32
looking after FS/2, 41
power, 43
programming FS/2, 167
the guides, 5
the LCD, 26
the screen, 26
this guide, 7
using communications, 149
UTIL, 77
Inverse video, 30, 87
IO.SYS, 175

Keyboard
- introduction, 32
autorepeat, 88
cleaning, 66
configuring, 19, 87
controls summary, 35
developer keyboard, 32, 365
differences from IBM, 35
foreign, 19
HOT key, 36
international, 19
layout, 33, 365
matrix codes, 368
modes, 32
overlay, 63
redefine key codes, 287
redefine PAW key codes, 290
redefine scan codes, 290
scan code, 369
select keyboard mode, 291
selecting keyboard modes, 32
special keys, 35
the PAW key, 35
user keyboard, 32, 366
Keyboard handler interrupt (16H), 280
clear keyboard buffer, 292
control Break keys, 291
control Ctrl Alt Del, 286
control emergency breakout, 286
control key repeat, 289
control keyclick, 288
control screen dump area, 288
control shift keys, 285
extended get key, 283
extended get shift status, 284
extended get status, 284
get key, 281
get key repeat, 289
get shift status, 282
get status, 281
redefine key codes, 287
redefine PAW key codes, 290
redefine scan codes, 290

reset extra keyboard variables, 292
reset keyboard, 288
select keyboard, 291
set key repeat, 282
set temporary shift, 285
write to buffer, 283
Keyboard overlay, 63
Keys
- summary, 32
backlight keys, 28
contrast keys, 17, 27
control keys, 35
flip key, 28
function keys, 35
HOT key, 36, 85
international characters, 19
looking keys, 28
map key, 29
mute key, 36
PAW key, 35
power key, 16, 25
reboot keys, 20
select keyboard mode key, 32
typing keys, 33
viewing keys, 28

LCD
- introduction, 26
adjusting, 27
and the CGA, 28
and the virtual screen, 28
backlight, 28
backlight timeout, 88
CGA compatibility, 27
cleaning, 26, 28
colours, 30
contrast, 27
controls, 27, 86
cursor synchronisation, 87
flip screen key, 28
inverse video, 30, 87
looking keys, 28
map key, 29
screen lookup key, 29
scrolling, 87
split screen, 29, 87
text attributes, 30
text font, 86
viewing angle, 27
viewing keys, 28
virtual screen, 27, 28
window, 28
Leap years, 79
Logical memory, 305
Looking after FS/2, 41
Looking after the LCD, 26, 28
Looking keys, 28
Low power
power-down, 17, 59
power level threshold, 17, 90
setting the threshold, 90
voltage level threshold, 18
warning, 59

Main serial port
see ‘Port 1’
Maintenance, 41
Map key, 29
Memory
configuring, 79
expansion, 165
FLASH EPROM, 165, 358
logical memory map, 305
maps, 304
paging, 305
physical memory map, 306
RAM, 79
types used, 358
Memory effect, 48
Meter reading probes, 166
Microprocessor interrupts, 183
MODE command, 141
Modem connector, 381
MS-DOS, 175
adapting applications, 179
compatibility with IBM, 36
configuring, 18
system files, 18
utilities provided, 36
MSDOS.SYS, 175

NiCads
see ‘Batteries’

Operating environment, 360
electromagnetic compatibility, 361

humidity, 360
pressure and elevation, 362
shock, vibration, impact, 361
storage conditions, 361
temperature, 66, 360
waterproofing and dustproofing, 360
Operating system, 175
Operating temperature range, 66, 360
Options
see ‘Expansion’

Paging, 305
Parallel printer port, 328
PAW key, 35
PC-DOS
see ‘MS-DOS’
Physical memory, 306
Port 1
configuring
see ‘Communications configuration’
connecting to, 125
electrical specification, 378
hardware emulation
see ‘8250 emulation’
pinouts, 378
using
see ‘Communications’
Port 2
configuring
see ‘Communications configuration’
connecting to, 125
electrical specification, 378
hardware emulation
see ‘8250 emulation’
pinouts, 378
using
see ‘Communications’
Power
also see ‘Batteries’
- introduction, 43
backup, 58
charging authorisation, 60
connecting the AC adaptor, 46
consumption calculations, 343
displaying, 86
idle timeout, 60
low power warning, 59
management modes, 17
modes and interrupts, 341
monitoring, 58
options, 164
outputs, 343
power-off timeouts, 342
power management modes, 58, 337
power outputs, 343, 377
power save mechanism, 60
power sources, 43
setting charging authorisation, 90
setting low power level, 90
setting up, 344
sources, 43
switchable devices, 342
usage calculations, 343
using an AC adaptor, 57
using fast discharge, 48, 347
using recharging, 45, 347
using SLOW mode, 346
Power down, 25
Power handling subsystem
- introduction, 58
- summary, 333
APM mode, 58, 338
battery capacity, 340
charging, 337
charging authorisation, 339
controlling power-down, 337
enabling charging, 339
facilities, 333
fast discharge, 340
idle timeout, 336
low power, 336
power-down causes, 335
power-down function, 337
power-down key, 336
power-saving, 340
power-up causes, 333
power-up keys, 334
power-up state, 334
power level, 339
power loss, 337
power management modes, 337
power modes, 341
power monitoring, 337
SPM mode, 58, 338
Power key, 13

Power management modes, 17, 58, 338
Power on, 16
Power outputs
  pinouts, 377
  rating, 377
  software control, 264, 273
PPI emulation, 317
Print screen interrupt (05H), 189
Printer control interrupt (17H), 293
  get printer status, 294
  initialise printer, 294
  print byte, 294
Problems
  - introduction, 65
  can't power down, 68
  can't power up, 67
  can't quit application, 68
  checking memory configuration, 75
  checking the RAM disk, 74
  communications error messages, 162
  EDIT error messages, 118
  error messages, 66
  LCD blank, 67
  program errors, 65
  reconfiguring system memory, 79
  reformatting drive C, 79
  solving problems, 66
  use outside temperature range, 66
  with clock, 73
  with comms parameters, 73
  with keyboard, 66, 69
  with RAM disk, 74
Programming
  - introduction, 167
  check memory size, 213
  check system equipment, 211
  interrupts, 183
  miscellaneous extensions, 243
  print screen, 189
  reboot, 295
  the disks, 215
  the hardware, 303
  the keyboard, 280
  the power handling system, 333
  the printer, 293
  the RTC, 297
  the screen, 191
  the serial ports, 221

Rack
  see 'Communications and charging rack'
Reboot interrupt (19H), 295
Rebooting
  see 'Booting'
Rechargeable batteries
  see 'Batteries'
Recharging batteries
  charging authorisation, 47
  controlling, 90
  procedure, 45
  reasons for failure, 47
  when to recharge, 45
Recycling batteries, 43
Repairs, 64
Replacing alkaline batteries, 52, 53
Replacing NiCads, 48, 50
Reset, 25
Reversed text
  see 'Inverse video'
Routine maintenance, 41
RS232
  see 'Port 1', 'Port 2'
RTC
  see 'Clock'

Screen
  see 'LCD', 'CGA' or 'Virtual screen'
Screen handler interrupt (10H), 191
  draw ellipse/circle, 202
  draw line/box, 203
  get backlight state, 208
  get backlight timeout, 201
  get contrast state, 208
  get cursor address, 194
  get cursor position, 194
  get cursor position (graphics), 201
  get graphics font, 207
  get video state, 198
  looking keys, 206
  move cursor, 194
  move cursor (graphics), 200
  read character and attributes, 196
  read pixel, 198

reset screen parameters, 207
scroll down, 195
scroll up, 195
select text font, 204
set backlight timeout, 201
set bold attribute mask, 208
set contrast, 201
set cursor size, 193
set display page, 195
set graphics font, 199
set inverse video mechanism, 204
set LCD window position, 206
set screen mode, 193
split display, 202
turn backlight on/off, 207
write character, 197
write character and attributes, 196
write character as TTY, 198
write pixel, 197
write string, 198
zoom, 206
Screen lookup key, 29
Screen synchronisation, 266
Screen window, 27
automatic movement, 27
moving, 28
size, 26
splitting, 29
Sealing, 42
Serial interface
see ‘Port 1’, ‘Port 2’
Serial number
reading, 252, 277
storing in RAM, 257
Serial port handler interrupt (14H), 221
check status, 225
clear COM1 Tx bit, 240
control 8250 emulation, 241
control CTS, 236
control handshake line, 235
control input buffering, 241
control RI power up, 237
control RS232 drivers, 236
detect RACK, 239
extended control, 234
extended initialise port, 225
extended protocol menu, 238
extended status, 235
get DTR, 238
get extended protocol parameters, 238
get installed protocols count, 237
get protocol handle, 237
get protocol name, 237
initialise port, 223
input character, 225
read comms parameters, 227
select comms parameters, 230
select modem communications mode, 240
select RACK communications mode, 239
send character, 225
set COM1 Tx bit, 240
set comms level, 239
set DTR, 238
Serial ports
see ‘Port 1’, ‘Port 2’
Setting the date, 79
Setting the time, 78
Shelf life, 64
Shell life, 361
Sockets
see ‘Connectors’
Software upgrades, 165
Solving problems, 66
Sound level key, 36
Sound output interrupt, 265
Special keys, 35
Specification, 353
Split screen, 29, 87
SPM mode, 17, 58, 89
also see ‘Power handling subsystem’
Status information, 86
Status key
see ‘HOT key’
Status line, 29
Storing FS/2, 64, 361
Synchronising scrolling, 87
System editor
see ‘EDIT’
System files, 18, 20, 175
disabling, 69
System utility
see ‘UTIL’

Temperature range, 66, 360
Text
  attributes, 30
  colours, 30
  fonts, 86
Time
  displaying, 86
  setting, 78
Timeouts
  backlight, 88
  idle turn off, 88
Timer emulation, 319
Transferring files, 152, 154, 155
Troubleshooting
  see ‘Problems’
Turning off, 25
Turning on, 16
Typefaces, 8

Unit serial number, 277
Upgrades, 64
Upgrades to the BIOS, 165
User keyboard, 32, 366
UTIL
  - introduction, 77
  communication port 1 setup, 81
  communication port 2 setup, 81
  format diskette option, 79
  format fixed disk option, 79
  set date option, 79
  set time option, 78
Utilities
  - summary, 36
  COM (simple file transfer), 152
  FLASHBAK (FLASH EPROM), 16, 58, 165, 170
  FLSHBIOS (BIOS update loader), 165
  HCOM (file transfer), 154
  HOT key (misc. functions), 85
  I (international keyboard support), 19
  MS-DOS, 36
  upgrades, 165
  UTIL (misc. functions), 77
  XL (XMODEM file loader), 155

Vectors, 183
Viewing angle, 27
Viewing keys, 28
Virtual screen, 27, 28
Volume control, 36

Warranty, 64
Waterproofing, 42
Welcome screen, 16, 25
Window, 27
  automatic movement, 27
  moving, 28
  size, 26
  splitting, 29

XL utility, 155
XMODEM loader utility, 155
XON/XOFF protocol, 129

ZONFIG.SYS, 69
ZUTOEXEC.BAT, 69